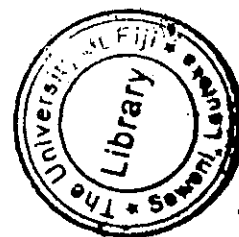




The University of Fiji



Foundation Studies Programme
School of Science and Technology
Semester 1 Year 2016

FINAL COURSE EXAMINATION PAPER

PHYF11: FOUNDATION PHYSICS I

Question Paper/Answer Booklet

Important Instructions to Students:

1. There are 16 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 the QUESTION PAPER provided. 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 and contributes 50% of the total course assessments.**
6. This paper contains two (2) sections A and B. Section A is compulsory to answer while Section B has choices.
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.

Examination Paper Content (Format):

<u>Section</u>	<u>Question</u>	<u>Content</u>	<u>Marks</u>	<u>Suggested Time</u>
A	1-15	Short Answer Questions (Answer ALL)	30	60 minutes
B	1-6	Long Answer Questions (Answer ANY 5)	70	120 minutes
		TOTAL	100	180 Minutes

Write the number of pages you have used	
Enter the question numbers in the order that you have answered them	Leave this column blank
Question Number	Marks (Official use only)
Total	
Percentage Marks	

DATA:

Acceleration due to gravity, $g = 9.8 \text{ m s}^{-2}$

Atmospheric pressure = $1.013 \times 10^5 \text{ Pa}$ (1 atm)

Avogadro number, $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$

Boltzmann constant, $k_B = 1.38 \times 10^{-23} \text{ J K}^{-1}$

Latent heat of fusion of water = $3.33 \times 10^5 \text{ J kg}^{-1}$

Latent heat of vaporization of water = $2.26 \times 10^6 \text{ J kg}^{-1}$

Mass of the Earth, $M_E = 5.98 \times 10^{24} \text{ kg}$

Radius of the Earth, $R_E = 6.38 \times 10^6 \text{ m}$

Specific heat capacity of ice, $c_{ice} = 2090 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$

Specific heat capacity of water, $c_{water} = 4186 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$

Stefan Boltzman constant, $\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$

Universal gravitational constant, $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

Universal gas constant, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$

SECTION A

Answer **ALL** questions in the space provided. Each question is worth 2 marks. You are advised not to spend more than an hour in this section.

A1. Hooke's Law states that the force, F , in a spring extended by a length x is given by $F = -kx$. From Newton's second law $F = ma$, where m is the mass and a is the acceleration, find the units of the spring constant k .

A2. A ball is projected horizontally from the top of a building. One second later, another ball is projected horizontally from the same point with the same velocity. Explain at what point in the motion the balls will be closest to each other.

A3. If the velocity of a particle is zero, can the particle's acceleration be zero? Explain.

A4. In the motion picture *It Happened One Night* (Columbia Pictures, 1934), Clark Gable is standing inside a stationary bus in front of Claudette Colbert, who is seated. The bus suddenly starts moving forward and Clark falls into Claudette's lap. Why did this happen?

A5. In a tug-of-war between two athletes, each pulls on the rope with a force of 200 N. Explain what is the tension in the rope?

A6. Torque and Work have the same fundamental dimensions but are completely different physical quantities. Explain how these two quantities are different from each other.

A7. The driver of a car slams on his brakes to avoid colliding with a stray dog crossing the highway. What happens to the car's kinetic energy as it comes to rest?

A8. Tarzan swings from a long vine to save Jane stranded at the bottom of the swing. After the catch, they both continue together on the swing. Explain how Tarzan's speed after catching Jane changes and compare the heights of the swing before and after the collision.

A9. Explain why a head-on collision is likely to be more dangerous than other types of collisions.

A10. An air bag inflates when a collision occurs protecting a passenger from serious injury. How does the air bag reduce the blow?

A11. Describe the path of an object moving with a constant acceleration perpendicular to its velocity.

A12. If global warming continues, it's likely that some ice from the polar ice caps of the Earth will melt and the water will be distributed closer to the equator. If this occurs, would the length of the day (one revolution) increase, decrease or remain the same. Explain.

A13. An ideal gas occupies a volume of 1.00 cm^3 at 20°C at 1 atm. Determine the number of molecules of gas in the container.

A14. For an ideal gas in an isothermal process, there is no change in the internal energy. Suppose the gas does work W during such a process. How much energy is transferred by heat?

A15. State the *Second Law of Thermodynamics*

SECTION A ENDS

Section B

Answer any five questions. Each question is worth 14 marks.

QUESTION B1

- a) The period of a spring-mass system oscillating on a frictionless surface is given by

$$T = 2\pi \sqrt{\frac{m}{k}}$$

Where m is the oscillating mass and k is the spring constant. Show that the equation is dimensionally consistent. [3 marks]

- b) A jet plane lands with a speed of 110 ms^{-1} and accelerates at -5.00 ms^{-2} as it comes to rest.

- i. From the instant the plane touches the runway, what is the time needed before it can come to rest?

[2 marks]

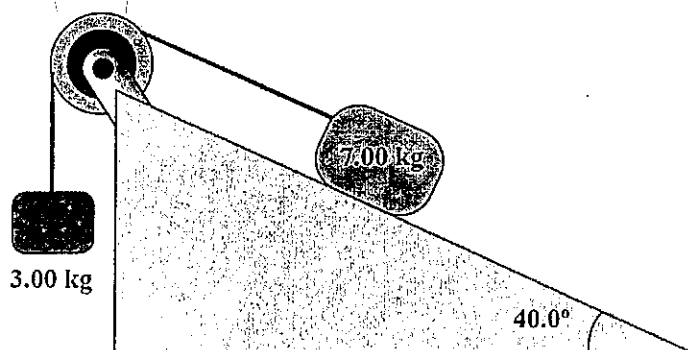
- ii. Can this plane land on a small tropical island airport where the runway is 0.900km long? Show your reasoning.

[2 marks]

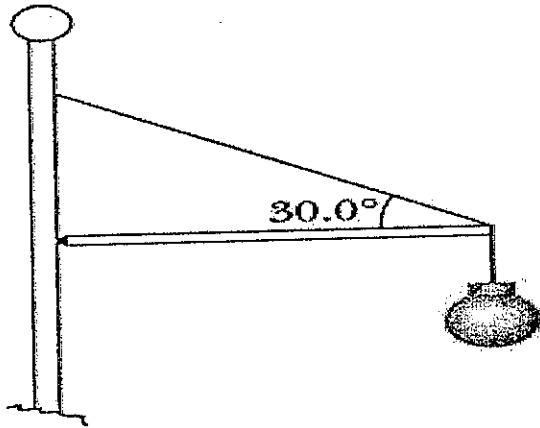
- c) A dog searching for a bone walks 5.50 m south, then 15.2 m at an angle 35° north of east, and finally 12.0 m west. Determine the dog's resultant displacement vector. Show your working clearly. [7 marks]

QUESTION B2

- a) Find the acceleration experienced by each of the two objects as shown. The coefficient of kinetic friction between the 7.00 kg object and the plane is 0.250. Assume the pulley and the string has negligible mass. [7 marks]

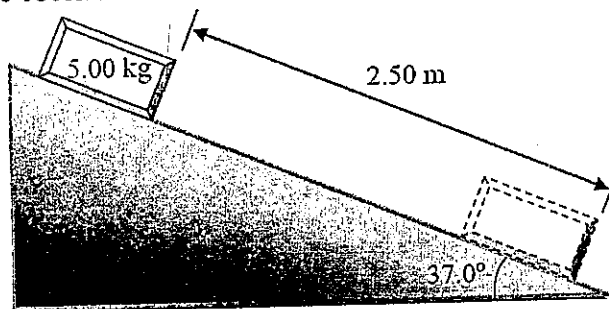


- b) A 20.0 kg floodlight is supported at the end of a horizontal beam of negligible mass that is hinged to a pole as shown. A cable at an angle of 30.0° with the beam helps to support the light. Find the tension in the cable and the horizontal and vertical components of the reaction force exerted by the pole on the beam. [7 marks]



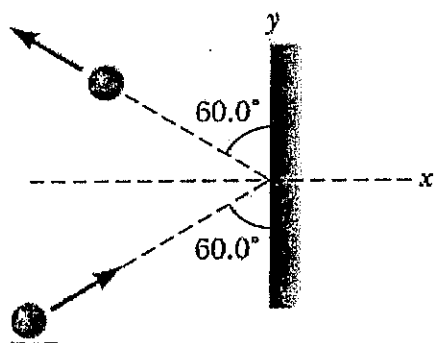
QUESTION B3

- a) A 5.00 kg block initially at rest slides a distance of 2.50 m down an incline plane as shown. The coefficient of kinetic friction between the block and the incline is $\mu_k = 0.436$.



- i. Determine the work done by the force of gravity. [2 marks]
- ii. Calculate work done by the friction force. [2 marks]
- iii. State the work-kinetic energy theorem and hence determine the speed of the block at the end of 2.50 m. [3 marks]

b) A 3.00 kg steel ball strikes a massive wall at 10.0 m s^{-1} at an angle of 60° with the plane of the wall. It bounces off the wall with the same speed and angle as shown in the figure. If the ball is in contact with the wall for 0.200 s, what is the average force exerted by the wall on the ball? [7 marks]



QUESTION B4

a) The tub of a washer goes into its spin-dry cycle, starting from rest and reaching an angular speed of 5.00 rev s^{-1} in 8.00 s . At this point, a person opens the lids, and a safety switch turns off the washer. The tub slows to rest in 12 s . Assuming a constant angular acceleration throughout, find:

- i. the angular displacement in the first 8.00 s . [2 marks]
- ii. the angular displacement after the person open the lid, and [2 marks]
- iii. the total number of revolutions during the entire 20.0 s period. [1 mark]

b) A bicycle wheel has a diameter of 64.0 cm and a mass of 1.80 kg . Assume the wheel is a hoop with all its mass concentrated on the outside radius. The bicycle is placed on a stationary stand, and a resistive force of 120 N is applied tangent to the rim of the tire. A force F is applied by a chain passing over a 9.00 cm diameter sprocket giving the wheel an acceleration of 4.50 rad s^{-2} .

Determine:

- i. the moment of inertia of the bicycle wheel [1 mark]
- ii. the resistive torque on the bicycle wheel, and [2 marks]
- iii. the force F applied by the chain passing over the sprocket. [3 marks]

c) A solid, horizontal cylinder of mass 10.0 kg and radius 1.00 m rotates with an angular speed of 7.00 rads^{-1} about a fixed vertical axis through its center. A 0.250 kg piece of putty is dropped vertically onto the cylinder at a point 0.900 m from the center of rotation and sticks to the cylinder. Determine the final angular speed of the system. [3 marks]

QUESTION B5

a) A satellite moves in a circular orbit around Earth at a speed of 5000 m s^{-1}

- i. What is the force keeping the satellite in orbit? Explain. [2 marks]
- ii. Determine the satellite's altitude above the surface of the Earth, and [3 marks]
- iii. Calculate the period of the satellites orbit. [2 marks]

b) A cylinder contains 2.00 mol of helium gas at 20.0°C. Assume the helium behaves like an ideal gas.

i. Find the total internal energy of the system. [2 marks]

ii. What is the average kinetic energy of one molecule? [2 marks]

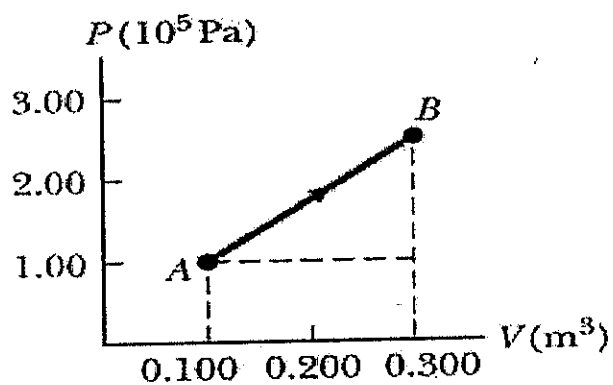
iii. How much energy must be added to double the rms speed? [3 marks]

QUESTION B6

a) A 5.00 kg block of ice at 0°C is added to an insulated container partially filled with 10.0 kg of water at 15°C .

- Determine if all the ice melts in water, and hence find the final temperature of water. [3 marks]
- Determine the mass of ice that has melted. [2 marks]

b) A quantity of 4.00 mol of a monatomic ideal gas expands from an initial volume of 0.100m^3 to a final volume of 0.300m^3 and pressure of $2.50 \times 10^5\text{Pa}$ as shown in the PV diagram.



Determine:

- i. the work done on the gas [2 marks]
- ii. the change in the internal energy of the gas, and [3 marks]
- iii. the thermal energy transferred to the gas. [2 marks]

c) A steam engine has a boiler that operates at 1000 K. The heat changes water to steam which drives a piston. The temperature of the exhaust is 300 K. What is the maximum possible thermal efficiency of this steam engine? [2 marks]

☺ THE END ☺

