



The University of Fiji



School of Science and Technology Department of Science

FINAL EXAMINATION SEMESTER 1, 2018

Question Paper

PHY F11: FOUNDATION PHYSICS I

Time Allowed: 3 hours

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

Important Instructions to Students:

1. There are 10 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 answer booklet 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 contributes 50% of the total course assessments.
6. There are three sections A, B and C. **Section A** – Answer all the multiple choice questions. **Section B** – Answer all the short answer questions. **Section C** – Answer all the long answer questions.
7. Write all your answers legibly. The marker has the right to award zero for answers that are not legible.
8. Unless stated otherwise, all symbols have their usual meanings
9. This is a closed book examination. The University views plagiarism, cheating and dishonest practice as serious offences and if found, offenders are penalized.
10. **Examination Paper Content (Format):**

<u>Section</u>	<u>Question</u>	<u>Content</u>	<u>Marks</u>	<u>Suggested Time</u>
A	1-16	Multiple Choice	16	30 minutes
B	B1-B12	Short Answer Questions	24	30 minutes
C	1-6	Long Answer Questions	60	120 minutes
		TOTAL	100	180 Minutes

Source:

Serway, R. A. and Vuille, C., [2015]. *College Physics*, (10th Edition). CENGAGE Learning, Stamford, USA.

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, σ	$= 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Universal gravitational constant, G	$= 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
Universal gas constant, R	$= 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$

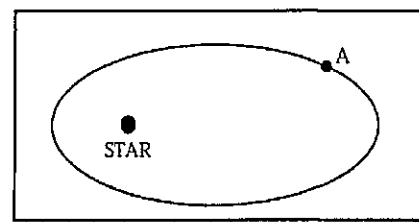
SECTION A**MULTIPLE CHOICE****16 MARKS**

There are **16** multiple choice questions. **Circle the best answer.** One mark will be awarded for every correct choice. All questions are compulsory.

Part I – Conceptual Questions

1. The value of the momentum of a system is the same at a later time as at an earlier time if there are no
 - a. collisions between particles within the system.
 - b. inelastic collisions between particles within the system.
 - c. changes of momentum of individual particles within the system.
 - d. internal forces acting between particles within the system.
 - e. external forces acting on particles of the system.
2. In order to jump off the floor, the floor must exert a force on you
 - a. in the direction of and equal to your weight.
 - b. opposite to and equal to your weight.
 - c. in the direction of and less than your weight.
 - d. opposite to and less than your weight.
 - e. opposite to and greater than your weight.
3. Two eggs of equal mass are thrown at a blanket with equal velocity. Egg B hits the blanket but egg A hits the wall instead. Compare the work done on the eggs in reducing their velocities to zero.
 - a. More work was done on A than on B.
 - b. More work was done on B than on A.
 - c. The amount of work is the same for both.
 - d. It is meaningless to compare the amount of work because the forces were so different.
 - e. Work was done on B, but no work was done on A because the wall did not move.
4. Stars originate as large bodies of slowly rotating gas. Because of gravity, these clumps of gas slowly decrease in size. The angular velocity of a star increases as it shrinks because of
 - a. conservation of angular momentum
 - b. conservation of linear momentum
 - c. conservation of energy
 - d. the law of universal gravitation
 - e. conservation of mass
5. A projectile starts at the coordinate origin, where the displacement vector also originates. The initial velocity, v_0 , makes an angle θ_0 with the horizontal where $0 < \theta_0 < 90^\circ$. At the instant when the projectile is at the highest point of its trajectory, the displacement, velocity and acceleration vectors are r , v and a . Which statement is true?
 - a. r is parallel to v .
 - b. r is perpendicular to v .
 - c. v is parallel to a .
 - d. v is perpendicular to a .
 - e. r is perpendicular to a .

6. The figure shows a planet travelling in a clockwise direction on an elliptical path around a star located at one focus of the ellipse. When the planet is at point A,

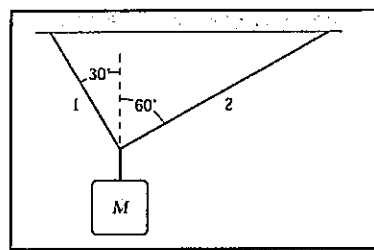


- its speed is constant.
 - its speed is increasing.
 - its speed is decreasing.
 - its speed is a maximum.
 - its speed is a minimum.
7. After a projectile has been launched from the ground, when will its velocity reach zero?
- when the projectile is released
 - when the projectile is at the maximum height
 - when the projectile starts to descend
 - when the projectile is just about to hit the ground
 - never.

Part II – Analytical Questions

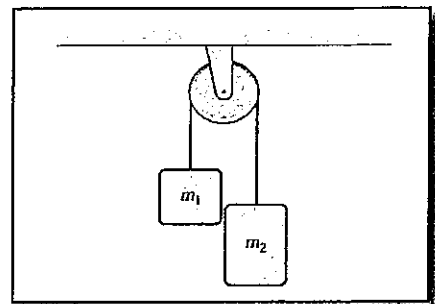
8. If $M = 6.0$ kg, what is the tension in string 1?

- 39 N
- 34 N
- 29 N
- 44 N
- 51 N



9. A 30-kg child rides on a circus Ferris wheel that takes her around a vertical circular path with a radius of 20 m every 22 s. What is the magnitude of the resultant force on the child at the highest point on this trajectory?
- 49 N
 - 0.29 kN
 - 0.34 kN
 - 0.25 kN
 - 0.76 kN
10. A 2.5-kg object falls vertically downward in a viscous medium at a constant speed of 2.5 m/s. How much work is done by the force the viscous medium exerts on the object as it falls 80 cm?
- +2.0 J
 - +20 J
 - 2.0 J
 - 20 J
 - +40 J

11. A spring ($k = 200 \text{ N/m}$) is suspended with its upper end supported from a ceiling. With the spring hanging in its equilibrium configuration, an object (mass = 2.0 kg) is attached to the lower end and released from rest. What is the speed of the object after it has fallen 4.0 cm ?
- 90 cm/s
 - 79 cm/s
 - 96 cm/s
 - 83 cm/s
 - 57 cm/s
12. A 2.0-kg object moving with a velocity of 5.0 m/s in the positive x direction strikes and sticks to a 3.0-kg object moving with a speed of 2.0 m/s in the same direction. How much kinetic energy is lost in this collision?
- 2.4 J
 - 9.6 J
 - 5.4 J
 - 0.6 J
 - 6.0 J
13. A 5.0 g particle moving 60 m/s collides with a 2.0 g particle initially at rest. After the collision each of the particles has a velocity that is directed 30° from the original direction of motion of the 5.0-g particle. What is the speed of the 2.0-g particle after the collision?
- 72 m/s
 - 87 m/s
 - 79 m/s
 - 94 m/s
 - 67 m/s
14. Two particles ($m_1 = 0.20 \text{ kg}$, $m_2 = 0.30 \text{ kg}$) are positioned at the ends of a 2.0-m long rod of negligible mass. What is the moment of inertia of this rigid body about an axis perpendicular to the rod and through the center of mass?
- $0.48 \text{ kg}\cdot\text{m}^2$
 - $0.50 \text{ kg}\cdot\text{m}^2$
 - $1.2 \text{ kg}\cdot\text{m}^2$
 - $0.80 \text{ kg}\cdot\text{m}^2$
 - $0.70 \text{ kg}\cdot\text{m}^2$
15. Two blocks, $m_1 = 1.0 \text{ kg}$ and $m_2 = 2.0 \text{ kg}$, are connected by a light string as shown in the figure. If the radius of the pulley is 1.0 m and its moment of inertia is $5.0 \text{ kg}\cdot\text{m}^2$, the acceleration of m_1 is
- $(1/6)g$
 - $(3/8)g$
 - $(1/8)g$
 - $(1/2)g$
 - $(5/8)g$



16. A satellite circles planet Roton every 2.8 h in an orbit having a radius of 1.2×10^7 m. If the radius of Roton is 5.0×10^6 m, what is the magnitude of the free-fall acceleration on the surface of Roton?
- a. 31 m/s^2
 - b. 27 m/s^2
 - c. 34 m/s^2
 - d. 40 m/s^2
 - e. 19 m/s^2

SECTION B

SHORT ANSWER

24 MARKS

There are 12 short answer questions which require your analytical, reasoning, logic and calculating skills. Two marks will be awarded for every correct answer. All questions are compulsory.

- B1.** State the SI unit of the following quantities: electric current, amount of substance, temperature and luminous intensity?
- B2.** Differentiate a vector quantity from a scalar quantity.
- B3.** A Lautoka Central bus is travelling at a speed of 50 m/s alongside a Sugar Taxi's van with a speed of 85 m/s on the Nadi Airport Road. What is the speed of the van relative to the bus?
- B4.** Fundamental and Non-fundamental forces are also known as conservative and non-conservative forces. Differentiate the **two** with examples.
- B5.** State the conditions necessary for translational and rotational equilibrium.
- B6.** Define elastic and inelastic collision
- B7.** A glass flask with volume 1000 cm^3 is filled to the brim with mercury at 20°C . How much mercury overflows when the temperature of the system is raised to 100°C ?
[$\alpha_{\text{glass}} = 0.4 \times 10^{-5} \text{ K}^{-1}$ and $\beta_{\text{mercury}} = 18 \times 10^{-5} \text{ K}^{-1}$]
- B8.** State the second law of thermodynamics.
- B9.** If the acceleration of an object is zero, can the velocity of that object be non-zero? Explain.
- B10.** *Torque* and *Work* have the same fundamental dimensions but are different physical quantities entirely. Explain their difference.
- B11.** An ideal gas occupies a volume of 1.00 cm^3 at 20°C and 1 atm. Determine the number of **molecules** of gas in the container.
- B12.** Explain isothermal process.

SECTION C**LONG ANSWER****60 MARKS**

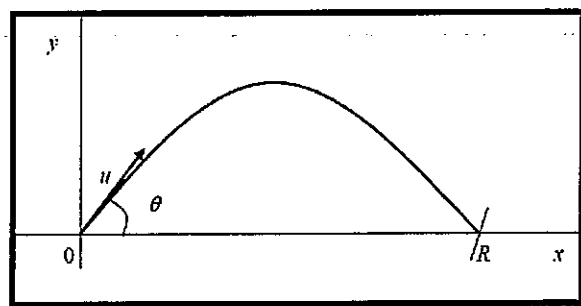
There are 6 long answer questions with 10 marks each. Each part has multiple and follow-up questions. Partial marks will be awarded for every correct approach. All questions are compulsory.

QUESTION 1

- a) State Newton's 3 laws of motion. [3 marks]
- b) Science and Engineering are based on measurements and comparison.
Find $\sqrt{x}$, if $x = (1.46 \pm 0.02)$ [2 marks]
- c) A man in the pursuit of losing weight walked (40.3 ± 0.1) m East and then walked (30.4 ± 0.1) m North. What is the total distance that he walked? What is his displacement at the end of the walk? [2.5 marks]
- d) A yacht is travelling directly across a river to the Marina Shed at a speed of 3 m/s relative to the water with a velocity of 8 m/s. Find the velocity of the yacht relative to the Marina Shed. [2.5 marks]

QUESTION 2

- a) How long will it take a cheetah accelerating at 2.2 m/s^2 from rest to reach a speed of 23 m/s? [2 marks]
- b) A \$1 coin just slips from the roof of the University of Fiji Quality Assurance Office and makes it way down to the car park. What is its velocity after 0.5 seconds and 2.5 seconds? [3 marks]
- c) During UPSM Sports Day touch rugby final, the ball is kicked by Year 2 with initial velocity u at an angle θ to the x-axis towards Year 5 as shown. Determine: the maximum displacement y ; the total time of flight of the ball; and the horizontal range, R .



Sourced from lecture notes of Mr. R. Prasad

[5 marks]

QUESTION 3

- a) Define centre of gravity.

[1 mark]

- b) Lionel Messi weighs 72kg and celebrates 2018 FIFA World Cup victory by holding onto the 1.5kg Golden trophy and standing on top of the 7.2m horizontal goal frame weighing 300N which is supported by posts A and B. Both the posts are at the bottom on the either ends of the horizontal beam and Messi is standing 3.2m from post B. find the tensile force on each post.

[3 marks]

- c) State impulse – momentum theorem and using Newton's second law, show that:

$$I = F \Delta t$$

[3 marks]

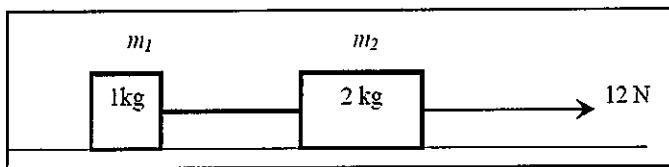
- d) Not wearing seat belt while driving is an offence according to the traffic laws of Fiji. Dimeisavu weighing 65kg drives a car weighing 780kg and while on her way to Suva at 100km/hr collides with a parked cane cart weighing 350kg in Sigatoka. Dimeisavu flies off through the windscreen and the car comes to a stop in 0.9 seconds. Determine the net force in the collision; and with what velocity did Dimeisavu fly off from the vehicle.

[3 marks]

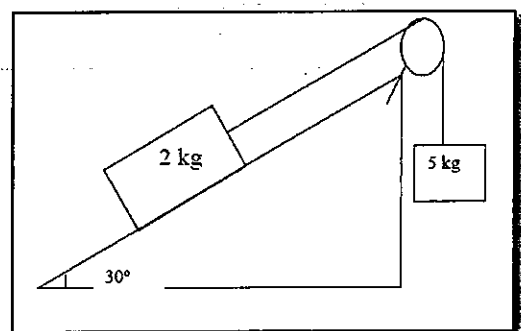
QUESTION 4

- a) Two masses ($m_1 = 1 \text{ kg}$ & $m_2 = 2 \text{ kg}$) are connected by a light inextensible string and pulled by a 12 N force along a frictionless surface as shown. Calculate the acceleration of the system and tension in the string.

[2 marks]



- b) A 5 kg and 2 kg crates are attached by a light string passing over a frictionless pulley of negligible mass as shown. The 2 kg crate lies on a 30° inclined wooden surface with coefficient of friction $\mu_s = 0.27$. Find the net force acting in the system; acceleration of the system; and the tension in the string.



[3 marks]

- c) A 50 g bullet is fired vertically up with a velocity of 250 m/s. Ignore the air resistance and using conservation of energy, determine the maximum height reached.

[2 marks]

- d) A 1.00×10^3 kg elevator carries a maximum load of 8.00×10^2 kg. A constant frictional force of 4.00×10^3 N retards its motion upward. What minimum power, in kilowatts and in horsepower, must the motor deliver to lift the fully loaded elevator at a constant speed of 3.00 m/s?

[3 marks]

QUESTION 5

- a) If the force acting between the moon and the Earth were F Newton's, what would be the new force in terms of F if the distance between them were doubled?

[2 marks]

- b) What will the weight of a 45.0 kg object be at a distance of 400 km from the surface of the Earth?

[2 marks]

- c) A satellite moves in a circular orbit around Earth at a speed of 5000 m/s. Determine
i. the satellite's altitude above Earth's surface; and
ii. the period of the satellite's orbit.

[2 marks]

- d) A hollow cylindrical shell [$I = MR^2$] with mass M and radius R rolls without slipping with speed v on a flat surface. What is its kinetic energy?

[2 marks]

- e) A metallic, horizontal cylinder [$I = \frac{1}{2} MR^2$] of mass 8.00 kg and radius 0.80 m is rotating with an angular speed of 6.00 rad s^{-1} about a fixed vertical axis through its center. When a 0.150 kg piece of plasticine is dropped vertically onto the cylinder at a point 0.90 m from the center of rotation, it sticks to the cylinder. Determine the **final angular speed** of the system.

[2 marks]

QUESTION 6

- a) In an automobile engine, a mixture of air and gasoline is compressed in the cylinder before being ignited. A typical engine has a compression ratio of 9:1. This means that the gas in the cylinder is compressed to one-ninth of its original volume. The initial pressure is 1 atm and the initial temperature is 27°C . If the pressure after compression is 21.7 atm, find the temperature of the compressed gas.

[3 marks]

- b) A Styrofoam box ($k = 0.045 \text{ W m}^{-2} \text{ }^{\circ}\text{C}^{-1}$) that is used to keep drinks cold at a picnic has a total wall area (including the lid) of 0.80 m^2 and a wall thickness of 2.0 cm . What is the rate of heat flow into the box if the temperature of the outside wall is 30°C ?

[3 marks]

- c) The efficiency of a Carnot engine is 30.0% . The engine absorbs 800 J of energy per cycle by heat from a hot reservoir at 500 K . Determine;
- the energy expelled per cycle;
 - the temperature of the cold reservoir.

[4 marks]

☺ THE END ☺