



The University of Fiji

SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF SCIENCE

FINAL EXAMINATION SEMESTER 1, 2015

FOUNDATION PHYSICS I

PHYF 11

Time Allowed: Three hours (3 hours)

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

INSTRUCTIONS

- 1.0 Write **all** your answers in the **Answer Book** provided.
- 2.0 There are seven **(7)** pages of questions in this Question Booklet (including the Cover Page)
- 3.0 Write your **Student Identification Number** on the front page of the **Answer Book**.
- 4.0 If you use extra sheets of paper, be sure to show clearly the question number(s) being answered and to tie each sheet securely in your Answer Book at the appropriate place.
- 5.0 There are **7** questions in this paper. **All the questions are compulsory.**
- 6.0 **Programmable calculators** are not allowed.
- 7.0 Unless otherwise stated, all symbols have their usual meanings.

DATA:

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

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

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

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

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

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

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

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

Rydberg's constant, $R = 1.097 \times 10^7 \text{ m}^{-1}$

Speed of light in a vacuum, $c = 3.0 \times 10^8 \text{ ms}^{-1}$

Coulomb's constant, $k = 9.0 \times 10^9 \text{ Nm}^2\text{C}^{-2}$

Charge on electron, $e = 1.6 \times 10^{-19} \text{ C}$

Electron mass, $m_e = 9.11 \times 10^{-31} \text{ kg}$

Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{ Fm}^{-1}$

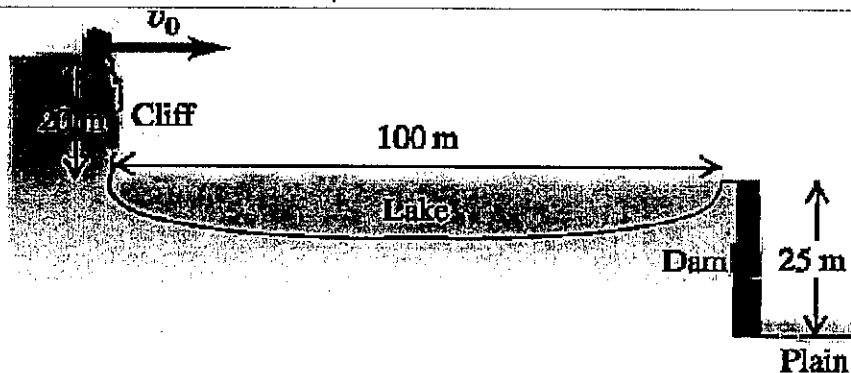
Permeability of free space, $\mu_0 = 4\pi \times 10^{-7} \text{ Tm.A}^{-1}$

Question 1 (Start on a new page)**[6 Marks]**

1. Convert 50 km/hr to m/s. [1]
2. An object moving at speed v around a circle of radius r has acceleration a directed towards the center of the circle, given by the equation: $a = \frac{v^2}{r}$. Use **dimensional analysis** to determine whether this equation might be valid. [2]
3. A plane leaves the Nadi airport and flies 100 km at 60° East of North and then changes direction to fly 200 km at 30° South of East, after which it makes an immediate emergency landing in a pasture on an island. When the airport sends out a rescue crew, in which **direction** and **how far** should this crew fly to go directly to this plane? [3]

Question 2 (Start on a new page)**[12 Marks]**

1. State Newton's second Law of Motion. [2]
2. A speed boat is travelling directly across a river at 6 m/s relative to the water. The speed of the water is 10 m/s relative to the ground. Determine the speed of the boat relative to the ground. [2]
3. A 76 kg boulder is rolling horizontally at the top of a vertical cliff that is 20 m above the surface of a lake, as shown in Figure below. The top of the vertical face of a dam is located 100 m from the foot of the cliff, with the top of the dam levels, with the surface of the water in the lake. A plain is 25 m below the top of the dam.



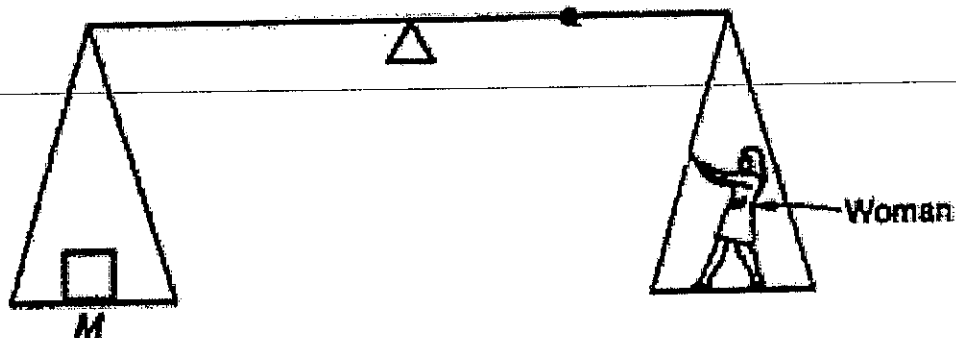
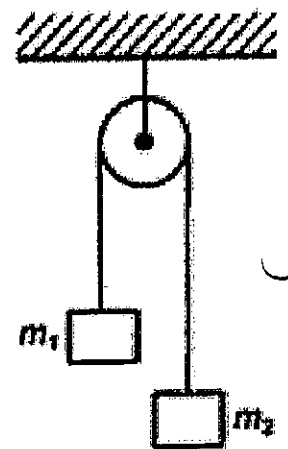
- a) Determine the time taken by the boulder to fall a vertical height of 20 m, in order to reach the top of the dam. [2]
- b) What must be the minimum velocity of the rock just as it leaves the cliff so it will travel to the plain clearing a distance of 100 m, without striking the dam? [2]

- c) Determine the time taken by the boulder to fall a vertical height in order to reach the plain. [2]
- d) How far from the dam does the rock hit the plain? [2]

Question 3 (Start on a new page)

[18 Marks]

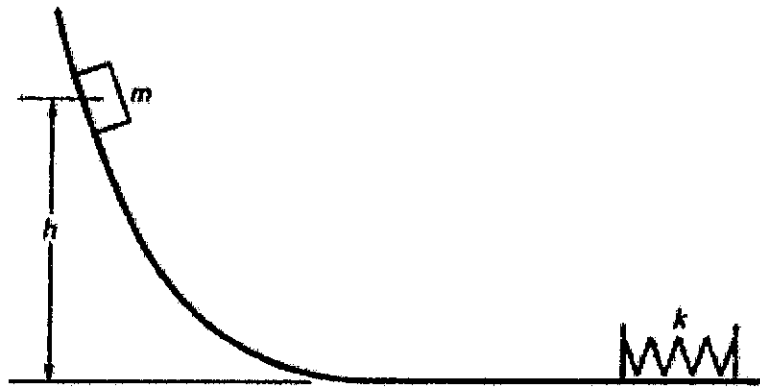
1. What are the two necessary conditions for static equilibrium? [2]
2. Two masses $m_1 = 5 \text{ kg}$ and $m_2 = 10 \text{ kg}$ are attached to the ends of a string hanging from a frictionless pulley as shown in the figure.
 - a) Determine the acceleration of the two masses after they are released. [3]
 - b) Determine the tension in the string connecting the two masses [2]
 - c) What is the velocity of the first block (m_1) 0.5 s after it is released, assuming the m_1 and m_2 does not run out of space. [2]
3. A woman of mass 65 kg stands on a large beam balance. The other platform holds a mass of M . If the woman is 120 cm from the pivot, while the mass M is 80 cm from pivot, determine the unknown mass M . [4]



4. A pendulum bob is hung on a string 1.00 m long and is displaced by a horizontal force so that the string makes an angle of 45° with the vertical. If the mass of the bob is 20.0 g:
 - a) what is the horizontal force required in giving the bob this displacement. [3]
 - b) determine the tension in the string. [2]

Question 4 (Start on a new page)**[19 Marks]**

1. How much work is required to change the velocity of a vehicle having of mass 1000 kg from 10.0 ms^{-1} to 18.0 ms^{-1} . [3]
2. A mass $m = 5 \text{ kg}$ slides from rest at a height of 1.2 m down a smooth curved surface which becomes horizontal at zero height as in the figure.
 - a) Determine the velocity of mass immediately before encountering the spring. [3]
 - b) The spring with $k = 40 \text{ N/m}$ is at the base of the frictionless curve. Determine the distance to which the spring will be compressed. [3]
 - c) To what height does the mass reach on returning to the curved part of the surface, if there is no energy loss in the spring? [1]



3. A 150 N resultant force acts on a 300 kg trailer. Calculate how long it takes this force to change the trailer's velocity from $2 \text{ m}\cdot\text{s}^{-1}$ to $6 \text{ m}\cdot\text{s}^{-1}$ in the same direction. Assume that the forces act to the right. [3]
4. Two cars of masses $m_1 = 1000 \text{ kg}$ and $m_2 = 500 \text{ kg}$ and velocities $v_1 = 18 \text{ km/h}$ and $v_2 = 36 \text{ km/h}$ collide at right angled intersection. After the collision they slide together as one.
 - a) Determine the combined velocity after collision. [3]
 - b) How much mechanical energy was lost during the collision? [3]

Question 5 (Start on a new page)**[20 Marks]**

1. An airplane propeller is rotating at 1900 rpm (rev/min).
 - a) Compute the propeller's angular velocity in rad/s. [2]
 - b) How many seconds does it take for the propeller to turn 135° ? [2]

2. The blade in a blender speeds up from 24 rad/s to 74 rad/s uniformly. During this time it turns through 40 revolutions. Calculate:
 - (a) The angle turned through in radians. [2]
 - (b) The angular acceleration. [2]
 - (c) The time taken to turn 40 revs. [3]
3. At what altitude above Earth's surface would the gravitational acceleration be 4.9 m/s^2 ? [3]
4. A typical human being has a mass of 70 kg.
 - a) Determine the force a full moon would exert on such a person when it is directly overhead with its centre 378, 000 km away? [3]
 - b) Determine the force exerted on the human by the Earth, and compare this with (a) above. [3]

Question 6 (Start on a new page)

[15 Marks]

1. Define *Latent heat of vaporization*. [2]
2. A Fiji Roads Authority surveyor uses a steel measuring tape that is exactly 50.000 m long at a temperature of 20°C , to measure lengths during four lane highway project from Nadi airport. What is the length of the tape on a hot scorching day when the temperature is 35°C ? The average coefficient of linear expansion of steel is $11 \times 10^{-6} / ^\circ\text{C}$. [3]
3. During a short spell of flu, an 80 kg man had a fever with elevated body temperature of 39°C instead of the normal body temperature of 37°C .
 - a) On the assumption that the human body is mostly water, how much heat is required to raise his temperature by that amount? ($C_{\text{water}} = 4186 \text{ J/kg.K}$) [3]
 - b) In fact, the specific heat of human body is 3480 J/kg.K . Compute the actual amount of heat required. [3]
4. An automobile tire has a volume of 0.0150 m^3 on a cold day when the temperature of the air in the tire is 5°C and pressure of 2.72 atm. After the car is driven on the highway for 30 minutes, the temperature of air inside the tire has risen to 45°C and the volume to 0.0159 m^3 . Determine the pressure of air in the tire. [4]

Question 7 (Start on a new page)

[10 Marks]

1. A diesel engine performs 2200 J of mechanical work and discards 4300 J of heat each cycle.
 - a) How much heat must be supplied to the engine in each cycle? [3]
 - b) Determine the thermal efficiency of the engine. [3]

2. State "*Carnot's Theorem*" [2]

3. In the First Law of Thermodynamics, Q and W depend on the path, while $\Delta W = Q - W$ is independent of path. What does independent of path mean? [2]

