UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

Surname and initials: _____

Student number: _____

DEPARTMENT OF PHYSICS

MODULE: PHYL01A/PHYL1A1

PHYSICS FOR THE LIFE SCIENCES

CAMPUS: APK

JUNE SUPPLEMENTARY EXAM

EXAMINER: **MR K MURULANE**

MODERATOR: **DR B SONDEZI**

DURATION: 150 MINUTES **MARKS: 120**

NUMBER OF PAGES: 21 PAGES (including this information page)

INSTRUCTIONS:

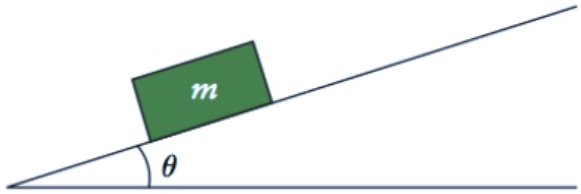
1. Answer ALL the questions in the question paper.
2. For question 1, circle the letters of the correct answers only.
3. Programmable calculators are not permitted.
4. Pencil may be used for diagrams only.
5. Work neatly

QUESTION 1 [20]

1.1 A particle is moving with a velocity $v = k(yi + xj)$, where k is a constant. The general equation for its path is

(a) $y = x^2$ + constant
(b) $y^2 = x^2$ + constant
(c) xy = constant
(d) $y^2 = x$ + constant **[2]**

1.2 A block of mass m rests on an inclined plane that makes an angle of θ with the horizontal, as shown in the figure below. What is the static friction between the block and the inclined surface?



(a) $f_s \geq mg$
(b) $f_s \geq mgcos\theta$
(c) $f_s = mgsin\theta$
(d) $f_s = mgcos\theta$
(e) zero, because the plane is inclined **[2]**

1.3 Two charges attract each other with a force F. If the magnitude of one of them is doubled, and the distance between them is doubled too, the magnitude of the force between them becomes

(a) 2F.
(b) F.
(c) F/2.
(d) F/4.

1.4 A 70.0 kg person stands on a bathroom scale in an elevator. What does the scale read, in kg, if the elevator is slowing down at a rate of 3.50 m/s^2 while descending?

(a) 49.5 kg
(b) 82.0 kg
(c) 83.7 kg
(d) 95.0 kg
(e) 111.0 kg **[2]**

1.5 When a torque acts on a rigid body, it always causes

(a) constant angular velocity
(b) constant angular acceleration
(c) rotational equilibrium
(d) change in angular velocity
(e) change in moment of inertia **[2]**

1.6 A particle of mass m moves in a circle of radius r with a constant speed v. The magnitude of its angular momentum is

(a) $\mathrm{m}r^2v$
(b) $(\mathrm{m}r)^2v$
(c) $\mathrm{m}v/r$
(d) $\mathrm{m}rv$ **[2]**

1.7 We study the ideal gas law. The gas constant can be given in different units; however, which of the following units is wrong:

(a) J/ (K mol)
(b) (atm m^3)/ (K mol)
(c) (Pa cm^2)/ (K mol)
(d) cal/ (K mol)
(e) None of the above; all are suitable for the gas **[2]**

1.8 If you perceive a point-like source of sound as too loud, you should move away from the source. This is because of the following relation between the sound intensity and the distance from the source.

(a) Intensity is independent of distance.
(b) Intensity increases linearly with distance.
(c) Intensity decreases linearly with distance.
(d) Intensity increases non-linearly with distance.
(e) Intensity decreases non-linearly with distance. **[2]**

1.9 When a torque acts on a rigid body, it always causes

(f) constant angular velocity.
(g) constant angular acceleration.
(h) rotational equilibrium.
(i) change in angular velocity.
(j) change in moment of inertia. **[2]**

1.10 When sound is absorbed in a medium, its intensity level IL decreases with distance travelled through the medium x as (Note: **β** is a constant)

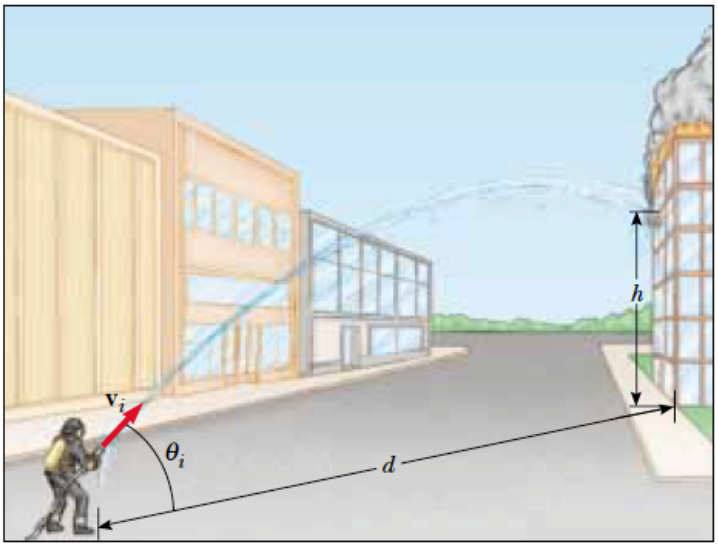
a) IL $\propto e^{-\beta x}$.
b) IL $\propto -x$.
c) IL $\propto b$.
d) IL $\propto \ln(-x)$. **[2]**

QUESTION 2 [30]

2.1 A Derive the kinematic equation $\Delta x = v_0 t + \frac{1}{2} a t^2$ for constant acceleration. Explain all steps and symbols used. **[6]**

2.2 A sled rider rode a rocket-propelled sled that moved down a track at a speed of 10 km/h. He and the sled were safely brought to rest in 1.40 s. Determine the negative acceleration he experienced and the distance he travelled during this negative acceleration. **[5]**

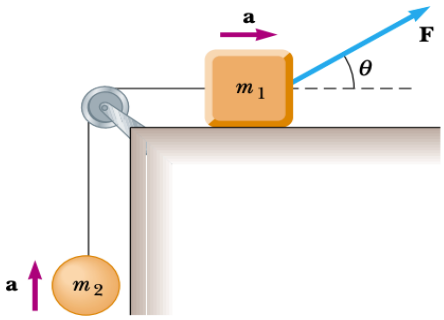
2.3 A firefighter, a distance $\boldsymbol{d}$ from a burning building, directs a stream of water from a fire an angle $\boldsymbol{\theta}$ above the horizontal as in figure below. If the initial speed of the stream is $\boldsymbol{v_i}$ at what height $\boldsymbol{h}$ does the water strike the building? **[4]**



2.4 You are in a taxi, sitting next to the driver. If he suddenly pushes the accelerator, you feel a push against your seat. If he suddenly pushes the brakes and comes to a stop , you feel a push forward toward the dashboard. Explain these situations according to the most suitable of Newton's laws. **[3]**

2.5 A 1800 kg car is travelling at 24 m/s when its brakes fail. The driver manages to turn off the engine. How far will the car go before it comes to stop if the force of friction between the tire and the road is 4900 N. **[6]**

2.6 block of mass m_1 on a rough, horizontal surface is connected to a ball of mass m_2 by a lightweight cord over a lightweight, frictionless pulley, as shown in the Figure below. A force of magnitude F at an angle with the horizontal is applied to the block as shown. The coefficient of kinetic friction between the block and surface is μ_k. Determine the magnitude of the acceleration of the two objects. **[6]**



QUESTION 3 [30]

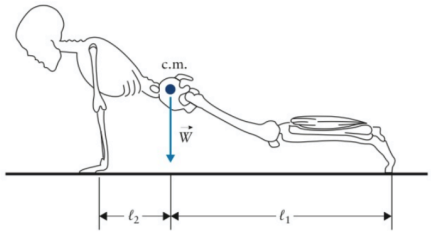
3.1 The mass of the Earth is 5.98×10^{24} kg, and the mass of the Moon is 7.36×10^{22} kg. The distance of separation, measured between their centres, is $3.84 \times 10^{8}\ m$. Locate the centre of mass of the Earth–Moon system as measured from the centre of the Earth. **[4]**

3.2 Show that the total linear momentum of an isolated system does not change in time. **[7]**

3.3 A car with a mass of 1200 kg and a speed of 12 $m/$s heading north approaches an intersection. At the same time, a minivan with a mass of 1300 kg and speed of 24 m/s heading east is also approaching the intersection. The car and the minivan collide and stick together. What is the velocity of the wrecked vehicles just after the collision? Ignore friction between the tires and the surface of the road. **[7]**

3.4 Explain why you cannot open a door by pushing on its hinge side **[2]**

3.5 A standard man is doing push-ups, as shown in the figure below. The distances are $l_1 = 90\ cm$ and $l_2 = 55\ cm$. Calculate the vertical component of the normal force exerted by the floor on both hands, and the normal force exerted by the floor on both feet. **[6]**



3.6 A 1.50-kg particle moves in the xy plane with a velocity of $\vec{v} = (4.2\,\hat{\imath} - 3.6\,\hat{\jmath})\ m/s$. Determine the angular momentum of the particle when its position vector is $\vec{r} = (1.5\,\hat{\imath} + 2.2\,\hat{\jmath})\ m$. **[4]**

QUESTION 4 [25]

4.1 If a person lifts an 18.0 kg bucket from a well and does 5.50 kJ of work, how deep is the well? Assume that the weight is lifted at a constant speed. **[5]**

4.2 A medical student volunteers to have his lung volumes measured for his organ physiology laboratory class. He is connected to a 3.0 L spirometer containing a concentration of helium which is 5% the volume of spirometer. He is instructed to breath several times until the helium has equilibrated between the spirometer and his lungs. He is then instructed to exhale as much air as he possibly can. Calculate the lung volume after the student has exhaled the maximum air out of his lungs provided only 3% of the helium concentration is left in the spirometer. **[6]**

4.3 Water boils at p = 1 atm and 100°C. Its density in the liquid state at the boiling point is $0.96\ g/cm^3$. Calculate the volume ratio of water vapour to liquid water at the boiling point. **Hint:** Model water vapour as an ideal gas. You may use a reference amount of water of 1 mol if this simplifies your calculations. **[6]**

4.4 State the first law of thermodynamic for a closed system and express it mathematically. **[3]**

4.5 A 1.0-mol sample of an ideal gas is kept at 0.0°C during an isothermal expansion from 3.0 L to 10.0 L. (a)Calculate the work done on the gas during the expansion and (b) the energy transferred by heat that occurs with the surroundings in this process .

[5]

QUESTION 5 [15]

5.1 The intensity of spherical wave 10 m from the source is 100 W/m^2 What is the intensity at a point 20 m away from the source? **[5]**

5.2 Given that the relation between the maximum transmitted and incident speeds is given by $v_t = \frac{2\rho_1 c_1}{2\rho_1 c_1 + 2\rho_2 c_2} v_i$. Derive the ratio of reflected to incident intensity R_I. **[6]**

5.3 Explain why an observer moving toward or away from a stationary source of sound perceives an apparent frequency that is not the true frequency of the source. **[4]**

----End of paper----