THE PAPUA NEW GUINEAUNIVERSITY OF TECHNOLOGY

ENTRANCE EXAMINATION – 2023

SUBJECT: PHYSICS

TIME ALLOWED: THREE (3) HOURS

INFORMATION FOR CANDIDATES

1. **You have ten (10) minutes to read this question paper. You are NOT to begin writing during this time.**
2. **There are eighteen (18) questions in this Question Paper. *Answer ALL* Questions.**
3. **You are to write your answers in the spaces provided for each question in this Question Paper. No other written materials will be accepted.**
4. **This examination Question Paper has a maximum of 100 marks.**
5. **You may use the DATA Sheet provided in this Question Paper.**
6. **You may use the calculators but mobile phones are NOT allowed.**

SURNAME:_____ **GIVEN NAME:** _____

Signature:_____ **Date:**_____

Location:_____

Intending Course:_____

_____*/100*

DO NOT WRITE UNTIL YOU ARE TOLD TO START.

Question 1 **(10 marks)**

(a) A boy runs from one end to the other end of a semi-circular path with radius 120 m. What is his displacement? **(2 marks)**

(Answer)

(b) A bicycle slows down its motion from 10 m/s to 6 m/s in 2 seconds under constant acceleration. What is its acceleration? **(2 marks)**

(Answer)

(c) Vector $\boldsymbol{A}$ = 2i + 3j and vector $\boldsymbol{B}$ = -i -2j. **(3 marks)**
What is the angle between vector $\boldsymbol{A}$ and vector $\boldsymbol{B}$?

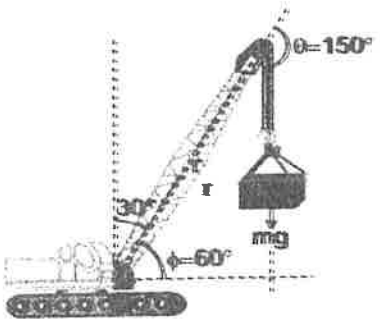
(Answer)

(d) An object moves at a constant speed of 9.0 ms^{-1} in a circular path of radius of 1.5 m. What is the angular acceleration of the object? **(3 marks)**

(Answer)

Question 2 **(6 marks)**

(a) A crane has an arm length of 20 m inclined at 30o with the vertical. It carries a container of mass of 2 tons suspended from the top end of the arm. Find the torque produced by the gravitational force on the container about the point where the arm is fixed to the crane.



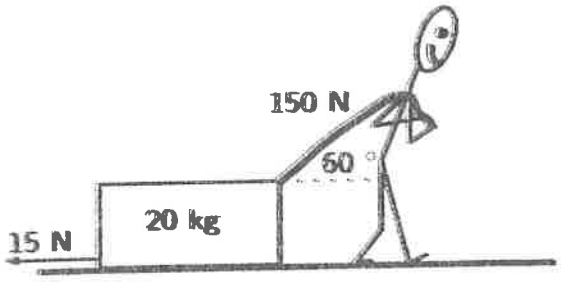
(Answer) **(3 marks)**

(b) A car driving at a speed of 20.0 m/s on level ground slams on its brakes. If it skids for 32.0 m before stopping, what is the coefficient of kinetic friction between its tires and the road?

(Answer) **(3 marks)**

Question 3 For parts (a) and (b) refer to the following information **(8 marks)**

Figure below shows a man pulling a 20 kg box with a rope that makes an angle of 60° with the horizontal. He applies a force of 150 N and a frictional force of 15 N is present.



(a) What is the acceleration of the box? **(3 marks)**
(Answer)

(b) What is the coefficient of kinetic friction? **(2 marks)**
(Answer)

(c) A person is standing on a weigh scale in an elevator. When the elevator is accelerating upward with constant acceleration **a**, the scale reads 867.0 N. When the elevator is accelerating downwards with the same constant acceleration **a**, the scale reads 604.0 N. What is the magnitude of the acceleration **a**. **(3 marks)**
(Answer)

Question 4 **(6 marks)**

(a) A bicyclist and his bicycle have a mass of 85.0 kg. The cyclist is travelling around a circular track of diameter 150.0 m at a constant speed of 7.9 ms^{-1}. What is the the force necessary to keep the cyclist moving around the track? **(2 marks)**

(Answer)

(b) Stone having mass 0.5kg rotates in horizontal. It is hanged on 1m rope. If the tension on the rope is 80 N, find the frequency of the motion. **(2 marks)**

(Answer)

(c) In a seesaw a child of mass 25 kg sits at one end that is 2 m away from the center. Another child of mass 20 kg sits at the other end.to balance the seesaw. How far is the second child from the center of the seesaw? **(2 marks)**

(Answer)

Question 5 **(6 marks)**

(a) Objects shown in the figure below collide. They stick and move together after the collision. What is the final combined velocity of the objects? **(3 marks)**

(Answer)

(b) A mass of 5.00 kg is moving at a constant speed of 10.0 m/s. A force of 200.0 N then acts on the mass for 2.00 s. What is the new speed of the mass? **(3 marks)**
(Answer)

Question 6 **(6 marks)**

(a) A 12.0 kg mass is hung from a spring with a spring constant of 2400 N/m. How much does the spring stretch from its equilibrium position? **(3 marks)**
(Answer)

(b) A body of mass 10 kg at rest is subjected to a force of 16 N. Find the kinetic energy at the end of 10 s. **(3 marks)**
(Answer)

Question 7 **(5 marks)**

In 35.0 s, a pump delivers 0.550 m^3 of oil into barrels on a platform 25.0 m above the pump intake pipe. The density of the oil is 820 kgm^{-3}.

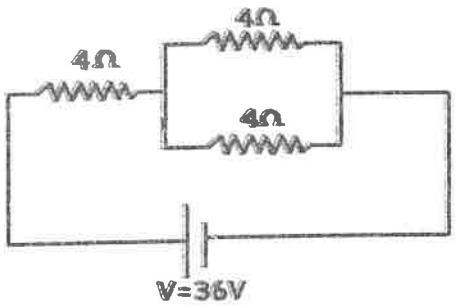
(a) Calculate the work done by the pump. **(3 marks)**

(Answer)

(b) Calculate the power produced by the pump. **(2 marks)**

(Answer)

Question 8 For parts (a) and (b) refer to the figure below. **(6 marks)**



(a) What is total current in the circuit? **(3 marks)**

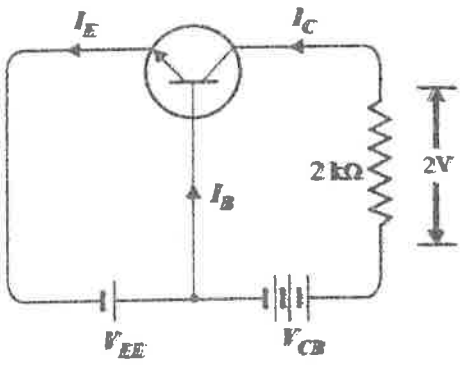
(Answer)

(b) What is the power loss through one of the resistances in the parallel part of the circuit? **(3 marks)**

(Answer)

Question 9 **(7 marks)**

(a) Refer to the figure below. In a common base connection, $\alpha = 0.95$. The voltage drop across 2 kΩ resistance which is connected in the collector is 2 V. What is the base current? **(3 marks)**



(Answer)

(b) Below is a truth table of a certain logic gate that has two inputs **A**, **B** and an output **Q**.

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

(i) Write the corresponding Boolean expression. **(2 marks)**

(Answer)

(ii) Draw the diagram of the corresponding logic gate. **(2 marks)**

Question 10 **(8 marks)**

(a) State Pascal's principle. **(2 marks)**

(Answer)

(b) In a machine shop, a hydraulic lift is used to raise heavy equipment for repairs. The system has a small piston with a cross-sectional area of 7.0×10^{-2} m^2 and a large piston with a cross-sectional area of 2.1×10^{-1} m^2. An engine weighing 2.7×10^3 N rests on the large piston. What force must be applied to the small piston in order to lift the engine? **(3 marks)**

(Answer)

(c) A sample of an unknown material weighs 300 N in air and 200 N when submerged in an alcohol solution with a density of 0.70×10^3 kg/m^3. What is the density of the material? **(3 marks)**

(Answer)

Question 11 **(8 marks)**

(a) Define thermal equilibrium. **(2 marks)**

(Answer)

(b) Explain the process of convection as one of the heat transfer methods. **(2 marks)**
(Answer)

(c) Define heat. **(1 mark)**
(Answer)

(d) The cooling system of a car engine contains 20.0 L of water (**1 L of water has a mass of 1 kg**). What is the change in the temperature of the water if the engine operates until 836.0 kJ of heat are added? **(3 marks)**
(Answer)

Question 12 **(8 marks)**

(a) Define transverse waves. **(2 marks)**
(Answer)

(b) A hiker shouts toward a vertical cliff 685 m away. The echo is heard 4.00 s later. If the wavelength of the sound is 0.750 m, what is the period of the wave? **(3 marks)**
(Answer)

(c) A beam of light strikes the flat, glass side of a water-filled aquarium at an angle of 40.0° to the normal. For glass, $n = 1.50$. At what angle does the beam enter the water? **(3 marks)**
(Answer)

Question 13 **(8 marks)**

(a) What is a galvanometer? **(1 mark)**
(Answer)

(b) Define magnetic flux. **(1 mark)**
(Answer)

(c) State Lens law. **(1 mark)**
(Answer)

(d) A circular loop of wire carries a constant current of 0.9 A. The radius of the loop is 13 mm. What is the magnetic field at the center of the loop? **(2 marks)**
(Answer)

(e) A straight conductor carrying a current of 5 A is located at 0.1 from an electron that is moving with a speed of 5×10^6 m/s parallel to the conductor. What is the magnetic force on the electron? **(3 marks)**
(Answer)

Question 14 **(8 marks)**

(a) Define isotopes. **(1 mark)**
(Answer)

(b) Define half-life. **(1 mark)**
(Answer)

(c) Radon-222, $^{222}_{86}Rn$, has a half-life of 3.82 days. How long will it take a sample of radon-222 with a mass of 0.75 g to decay into other elements, leaving only 0.09 g of it? **(3 marks)**
(Answer)

(d) **(3 marks)**
Refer to the decay equation below.

$$^{239}Pu \longrightarrow {}^{235}U + {}^{4}He$$

The units of masses are as follows:

$m(^{239}Pu) = 239.052157u$, $m(^{235}U) = 235.043924u$, $m(^{4}He) = 4.002602u$.

Calculate the energy released in this reaction.
(Answer)

END OF EXAMINATION

Data Sheet

$\pi = 3.14$

$g = 10\ m/s^2$

$v = u + at$

$v^2 = u^2 + 2as$

$s = ut + \frac{1}{2}at^2$

$w = mg$

$f_k = \mu_k \eta = \mu_k mg$

$\Delta l = l_o \alpha \Delta T$

$c = 3.0 \times 10^8\ m/s$

$F_B = \rho Vg$

$C_{ice} = 2060\ J/kg°C$

$L_{vwater} = 2.26 \times 10^6\ J/kg$

$F = qvB\sin\theta$

$\rho_{waterr} = 1000\ kg/m^3$

$s = 343\ m/s$

$v = \lambda f$

$F\Delta t = m\Delta v$

$E = (\Delta m)c^2$

$n = c/v$

$F_y = F\sin\theta$

$F_1/A_1 = F_2/A_2$

$c = 2\pi r$

$n_{water} = 1.33$

$e = 1.6 \times 10^{-19} C$

$w = \eta + ma$

$v = u - gt$

$v^2 = u^2 - 2gh$

$h = ut - \frac{1}{2}gt^2$

$f_s = \mu_s \eta = \mu_s mg$

$p = mv$

$\Delta V = V_o X \Delta T$

$C_{water} = 4180\ J/kg°C$

$L_{fice} = 3.34 \times 10^5\ J/kg$

$\rho_{air} = 1.20\ kg/m^3$

$v = \sqrt{\frac{T}{\mu}}$

$\Delta p = m\Delta v$

$A_1v_1 = A_2v_2$

$Q = mc\Delta T$

$V_1 = V_2 \Longrightarrow A_1h_1 = A_2h_2$

$F = ma$

$d = 2r$

$h = 6.62 \times 10^{-34}\ J.s$

$F = BIL\sin\theta$

$\frac{\sin Q_1}{\sin Q_2} = \frac{v_1}{v_2}$

solenoid
$B = \mu_o N/L \times I = \mu_o nI$

$v = 2\pi r/T$

$1u = 931.5 MeV/c^2$

$\rho = m/V$

$F = kx$

$KE = 1/2mv^2$

$U = mgh$

$\Delta A = A_o \beta \Delta T$

$U = 1/2kx^2$

$\tau = r \times F = Fr\sin\theta$

$F = mv^2/r$

$F_B = \rho Vg$

Current-Carrying Circular Loop

$B = \mu_o I/2R$

$1\ rev = 2\pi\ rads = 6.28\ rads$

$W = Fd$

Electrical power, $P = IV = I^2R = \frac{V^2}{R}$

$\mu_o = 4\pi \times 10^{-7} T.mA^{-1}$

$n_1 \sin Q_1 = n_2 \sin Q_2$

Resistance in parallel,

$R_T = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + --\right)^{-1}$

$F_x = F\cos\theta$

Resistance in series,

$R_T = (R_1 + R_2 + R_3 + --)$

$n_{air} = 1$

Current-Carrying Conductor
$B = \mu_o I/2\pi r$

$E = hf$

$a = \alpha r$