Class | Adm No

Candidate Name: _____

2024 Preliminary Examination
Pre-University 3

H2 PHYSICS **9749/03**

Paper 3 Longer Structured Question

Section B Booklet **16 September**

Candidates answer on the Question Paper. **2 hours**

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Do not turn over this page until you are told to do so.

Write your full name, class and Adm number in the spaces at the top of this page.

Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.

Section B
Answer **one** question only. **Circle** the question number on the cover page

You are advised to spend one and half hours on Section A and half an hour on Section B.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use		
Section B (Circle 1 question)		
7		/ 20
8		/ 20
Presentation		

Section B

Answer **ONE** question from this Section in the spaces provided.

7 **(a)** Explain what are meant by the *moment of a force* and the *torque of a couple*. Distinguish between the two terms.

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…….. [3]

(b) One type of weighing machine, known as a steelyard, is illustrated in Fig. 7.1

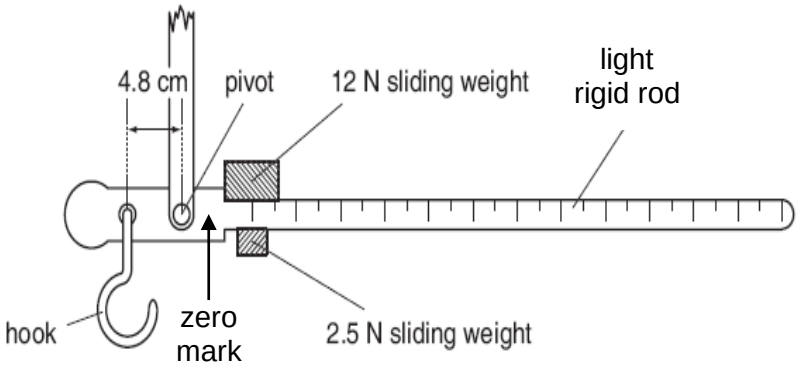

Fig. 7.1

The 12 N and 2.5 N sliding weights can be moved independently along the light rigid rod.

With no load on the hook and the sliding weights at the zero mark on the rigid rod, the rod is horizontal. The hook is 4.8 cm from the pivot.

(i) Explain why the light rigid rod can remain horizontal with no load on the hook.

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……[1]

(ii) Explain why the perpendicular distance from the hook to the pivot is deliberately kept shorter compared to the length of the rigid rod.

……..……

……..…

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……..…… [2]

(iii) A sack of flour is suspended from the hook. In order to return the light rigid rod to the horizontal position, the 12 N sliding weight is moved 84 cm along the rod and the 2.5 N sliding weight is moved 72 cm.

Calculate the mass of the sack of flour.

mass= ……kg [2]

(iv) Explain why this steelyard would be less accurate when weighing objects with a weight of about 25 N.

……

……

……[2]

(c) **(i)** By referring to work done being the product of force and the displacement in the direction of the force, derive the formula $E_p = mgh$ for potential energy changes near the Earth's surface.

[3]

(ii) A typical escalator rises at an angle of 30º to the horizontal. It lifts people through a vertical height of 15 m in 0.50 minute. Assuming all the users stand still while on the escalator, 60 users can get on at the bottom and get off at the top in 0.50 minute. The average mass of a user is 55 kg.

1. Determine the average power needed to lift the users when the escalator is fully laden.

Assume that any kinetic energy transferred to the users by the escalator is negligible.

average power = ……W [2]

2. The frictional force in the escalator system is 1.0×10^4 N when the escalator is fully laden.

Calculate the power to overcome friction.

power = ……W [3]

3. When there are 60 users walking up the moving escalator, instead of standing still, at any point in time, explain whether more or less power is required by the motor to maintain the escalator at the same speed.

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……[2]

[Total: 20]

8 (a) Radioactive decay is a random and spontaneous process. The stationary radioactive isotope Plutonium-238 $\left({}^{238}_{94}\text{Pu}\right)$ decays by emitting an alpha particle.

The daughter nucleus is an isotope of Uranium. The mass of ${}^{238}_{94}\text{Pu}$ is 238.0496 u and the mass of an α-particle is 4.0026 u.

(i) Explain what is meant by a spontaneous process.

……..…….....

……..…….....

……..…….....[2]

(ii) Write down an equation representing the decay, indicating clearly the atomic number and mass number of each nucleus.

……..…….....[2]

(iii) Given that the total kinetic energy of the products is 5.649 MeV, calculate,

1. in terms of atomic mass units, the mass of the uranium nucleus formed in the reaction,

mass of uranium nucleus = ……u [3]

2. the ratio of the kinetic energy of the α-particle to that of the uranium nucleus formed,

ratio = ……..…… [3]

3. the kinetic energy of the α-particle, in MeV.

kinetic energy of α-particle = ……MeV [2]

(b) Fig. 8.1 shows a simple experiment set up by a student to estimate the activity of a radioactive source. The source emits α, β and γ-radiation particles and is placed 10 cm from a detector that is connected to a counter.

The detector is capable of detecting all types of radioactive emissions.

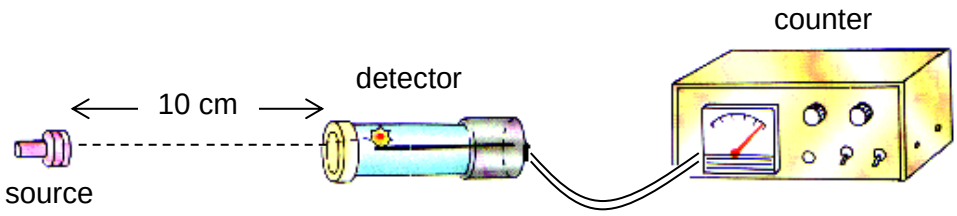

Fig. 8.1

(i) Distinguish between α and γ-radiation in terms of their relative ionizing strength and penetrating abilities.

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……[2]

(ii) Explain whether emission of α-particles will be detected in the above set-up.

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……[1]

(iii) Without the source, the counter gives a count-rate of 600 min^{-1}. When the source is placed 10 cm in front of the detector, the following count rates are observed at two different times, *t.*

t / hour	Count-rate / min^{-1}
0	7009
6.0	1401

Calculate the half life of the source.

half-life = …….. hours [3]

(iv) State two effects of ionizing radiation on living tissues and cells.

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……..…….....[2]

[Total: 20]

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