EUNOIA JUNIOR COLLEGE
JC2 MID YEAR EXAMINATION 2022
General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME	

CIVICS GROUP	2	1	-			REGISTRATION NUMBER	

PHYSICS
8867/02

Paper 2 Structured Questions

June 2022

2 hours

Candidates answer on the Question Paper

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.
Do not use paper clips, highlighters, glue or correction fluid.
Answer **all** questions.
The use of an approved scientific calculator is expected where appropriate.

Structured Questions

Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	5
2	10
3	10
4	15
5	20
6	10
7	10
s.f.	
c.f.	
Total	80

This document consists of **17** printed pages and **1** blank page.

Data

speed of light in free space	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
unified atomic mass constant	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
the Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
gravitational constant	$G = 6.67 \times 10^{-11}$ N m^{2} kg^{-2}
acceleration of free fall	$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$

Answer **all** the questions in the spaces provided.

1 The variable resistor is adjusted to give a new set of readings which, when repeated, give values of voltage V and current I of (3.00 ± 0.03) V and (4.9 ± 0.1) mA respectively.

(a) Estimate the percentage uncertainty in the value of the unknown resistance X as a result of the uncertainties in the values of V and I.

percentage uncertainty = ………………….. % [2]

(b) Determine the unknown resistance X and express it with its associated uncertainty to the appropriate number of significant figures.

resistance = …………………..±…………….. Ω [3]

2 **(a)** Define acceleration.

....

....[1]

(b) A stone is projected from a cliff on a faraway planet. It travels from point A, through point B and to point D as shown in Fig. 2.1. The horizontal dotted line AB is at a vertical distance of 1.1 m above the horizontal dotted line CD. The initial velocity of the stone is 5.0 m s^{-1} at 30° to the horizontal. Assume air resistance is negligible.

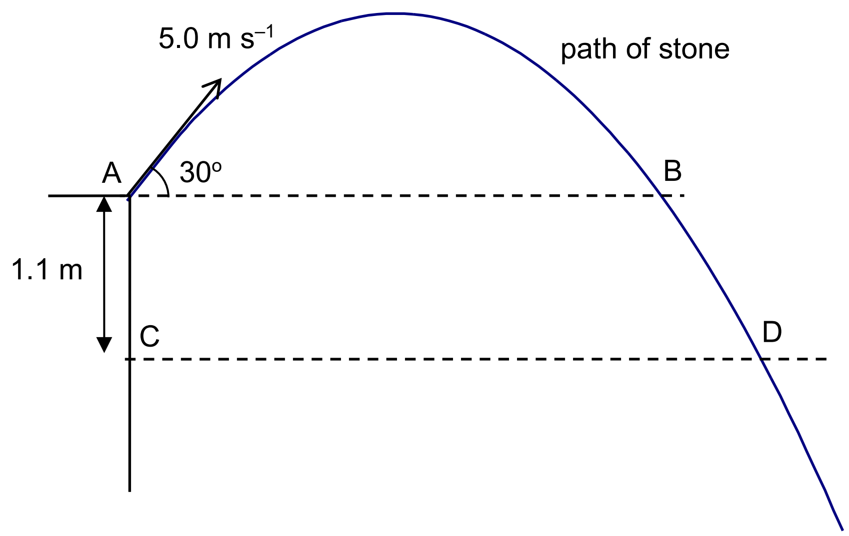

Fig. 2.1

Fig. 2.2 shows the variation of the stone's vertical velocity with time.

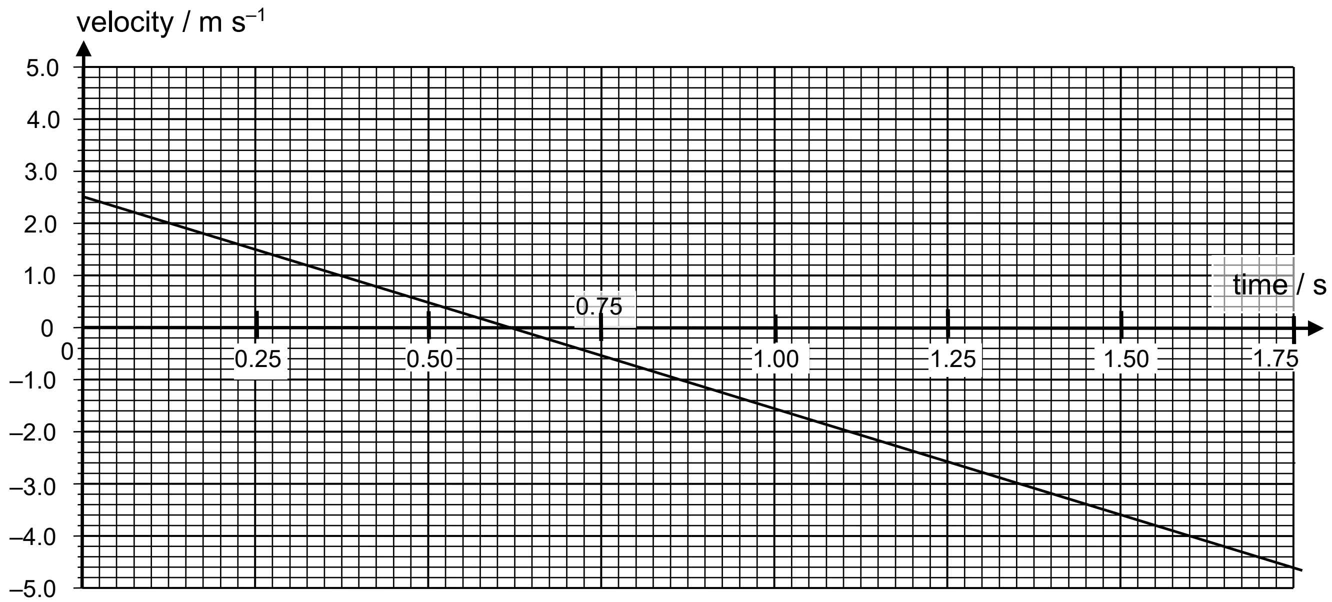

Fig. 2.2

(i) Determine the acceleration in the vertical direction.

acceleration = ………………….. m s^{-2} [2]

(ii) Calculate the vertical velocity of the stone at point D.

velocity = ………………….. m s^{-1} [2]

(iii) Determine the time of flight from point A to point D.

time = ……………………….. s [2]

(iv) Shade on Fig. 2.2 the area corresponding to the vertical displacement between point B and D. [1]

(v) Mark with an 'X' on the line in Fig. 2.2 when the direction of velocity is 45° with respect to the vertical. Briefly explain your answer.

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

……………………………………………………………………………………………….…[2]

3 **(a)** State the principle of conservation of momentum.

………

………

……… [2]

(b) A bullet of mass 10 g strikes a stationary block horizontally with a speed of 100 m s^{-1}. The block rests on a frictionless surface. The time that elapses from the instant the bullet strikes the block to the instant it just emerges from the other side of the block is 0.030 s. During this time, the bullet's deceleration is 900 m s^{-2} and the block's acceleration is 300 m s^{-2}, both with respect to ground.

(i) Calculate the final speeds of

1. the bullet,

final speed of bullet = ……………….. m s^{-1} [1]

2. the block.

final speed of block = ……………….. m s^{-1} [1]

(ii) Calculate the impulse of the force on the bullet during the collision.

impulse = …………………………… [2]

(iii) Determine the mass of the block.

mass = ……………………………… kg [2]

(iv) Deduce if the collision between the bullet and block was elastic or inelastic.

………

……… [2]

4 (a) (i) State the conditions for equilibrium for a rigid body.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

(ii) A 4.0 m high column has a mass of 180 kg and its centre of gravity **X** is at a distance of 2.3 m from the base as shown in Fig. 4.1. A group of men was pulling on the rope to provide a tension, *T*. The rope makes an angle of 35° to the column and the column itself makes an angle of 45° to the horizontal.

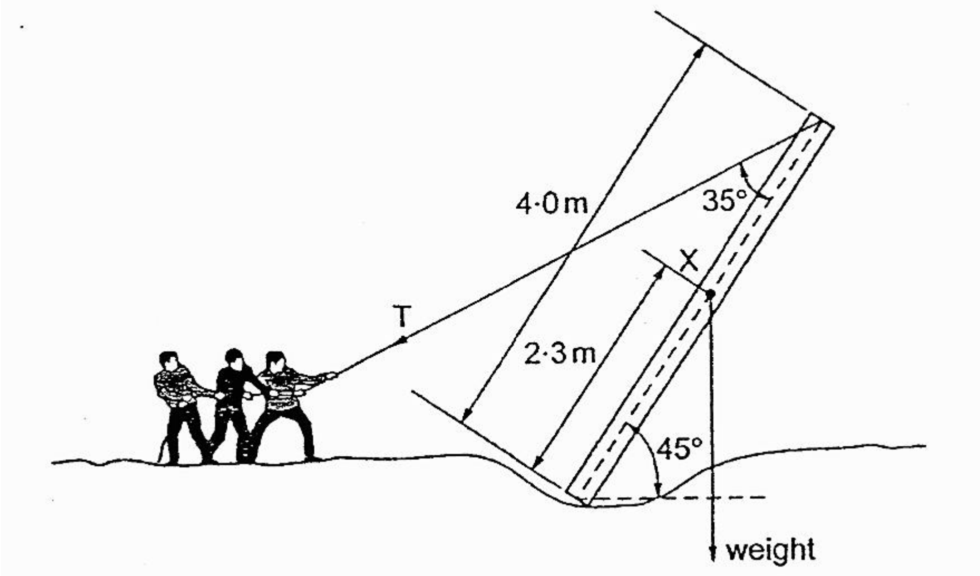

Fig. 4.1

1. When the column is held at equilibrium as shown in Fig. 4.1, show that the moment exerted by the weight of the column about the base is 2.87×10^3 N m.

[1]

2. Calculate the tension *T* in the rope.

T = ……………………..…. N [2]

3. Sketch on Fig. 4.1 the direction of the force exerted by the ground on the column to keep the column in equilibrium. [1]

4. As the men start to pull the column towards them, the column rotates anti-clockwise. The angle between the column and rope is kept constant. State and explain how the amount of tension required for equilibrium would change before the column is upright.

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…………………………………………………………………………………………… [2]

(b) A 5.0g metallic ball bearing is allowed to rest on a spring of elastic constant k = 500 N m^{-1}. The ball is pushed down 2.0 cm from its uncompressed position and then released as shown in Fig. 4.2 (a) and Fig. 4.2 (b).

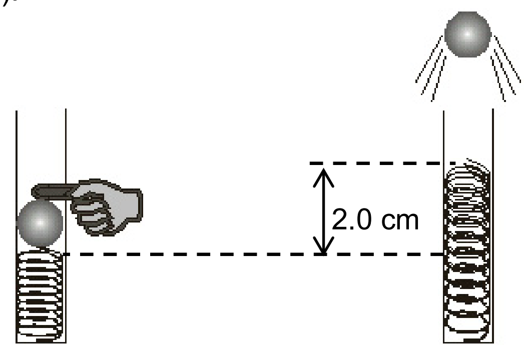

Fig. 4.2 (a) **Fig. 4.2 (b)**

(i) Calculate the maximum height H to which the ball bearing will rise from its lowest position.

.

H = ……..…………….. cm [2]

(ii) Explain clearly the transformation of energy of the ball bearing when it is released from the compressed position of the spring until it reaches the maximum height H.

..........……………………………………………………………………………………………

………………....…………………………………………………………………………………

…………………………………………………………………………………….……………… [2]

(iii) Sketch the variations of the different energies in (b)(ii) as a function of height starting from the ball bearing's lowest compressed position to its highest point. Label the sketch appropriately. Let gravitational potential energy at the lowest point be zero.

[3]

5 **(a)** A boy swings a pendulum bob of mass 20 g attached to a string of length 40 cm in a vertical circle. He deliberately reduces the speed of the motion until the string is barely taut when the bob is at the highest point of the circular motion. Assuming that he has achieved this motion,

(i) calculate the speed of the bob at the highest point of the circular motion.

speed = ………………….. m s^{-1} [3]

(ii) calculate the speed of the bob at the lowest point in the circular motion.

speed = ………………….. m s^{-1} [2]

(b)

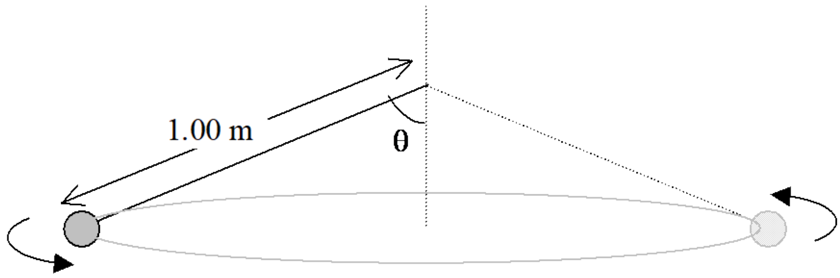

Fig. 5.1

A student performs an experiment in which he swings a pendulum bob of mass 50.0 g attached to a light inextensible string of length 1.00 m in a horizontal circle as shown in Fig. 5.1. Using a stopwatch, he finds that the periodic time of the circular motion is 1.20 s. Determine

(i) the tension in the string.

tension = ………………….. N [3]

(ii) the angle θ between the string and the vertical.

θ = ………………….. ° [2]

(c) Fig. 5.2 shows a planet rotating about its axis PQ that joins its centre and poles with a period of 1.35 hours. The planet has a radius of 8750 km and a mass of 2.46 x 10^{25} kg. An inhabitant of mass 65.0 kg is standing on the planet at the position X. The angle $\angle XOY$ is 60.0°.

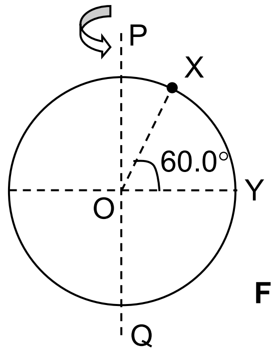

Fig. 5.2

(i) Calculate the angular speed, in rad s^{-1}, of the planet.

angular speed = ………………….. rad s^{-1} [1]

(ii) Calculate the centripetal force acting on the inhabitant.

force = ………………….. N [2]

(iii) State and explain the reason why the linear speed of the inhabitant is constant, despite the fact that a resultant force is acting on it.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

(iv) Calculate the gravitational force acting on the inhabitant.

force = ………………….. N [2]

(v) The contact force acting on the inhabitant at X is C. Using the values from (ii) and (iv), calculate this contact force.

C = ………………….. N [2]

(vi) State what happens to the direction and magnitude of the centripetal force when the mass of the inhabitant is increased.

……………………………………..………..……………………………………………...

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……………………………….……………………………………………………………..…[1]

6 (a) A steel ball is projected horizontally from the top of a table. An electron is projected horizontally into a uniform electric field acting vertically upwards in an evacuated space.

(i) Explain clearly why the ball and the electron follow similar paths.

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……

………………………………………………………………………………………………… [2]

(ii) Estimate the value of the electric field strength if the acceleration of the electron due to the electric field is to be 10^{15} times its acceleration due to gravity.

electric field strength = ……………………………N C^{-1} [2]

(b) Singly-charged tin ($^{118}Sn^{+}$) ions enter a magnetic deflection region as shown in Fig. 6.1.

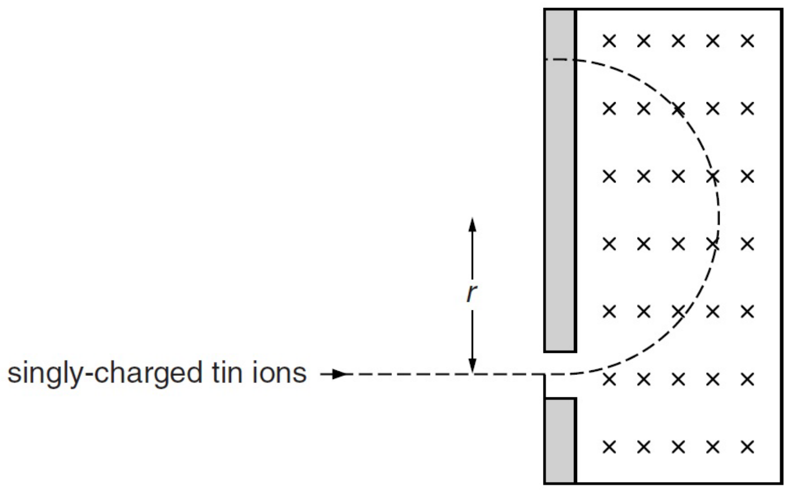

Fig. 6.1

The magnetic force on the ions acts centripetally.

(i) Show that the radius *r* of the path of an ion of charge *q* and mass *m* moving at velocity *v* in a magnetic field of strength *B* is given by

$$r = \frac{mv}{Bq}$$

[3]

(ii) Calculate the radius of the path followed by a singly-charged $^{118}Sn^{+}$ ion of mass 2.0×10^{-25} kg with a speed of 1.8×10^{5} m s^{-1}. The magnetic field in the deflection region is 0.70 T.

radius = ………………………………… m [1]

(iii) The sample of tin also includes more massive singly-charged $^{120}Sn^{+}$ ions which enters at a speed of 1.8×10^{5} m s^{-1}. Describe and explain how their path through the same magnetic field differs from the path of $^{118}Sn^{+}$ ions.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [2]

7 When a neutron is captured by a uranium-235 nucleus, the outcome may be represented by the nuclear equation shown below.

$$^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{95}_{42}\text{Mo} + {}^{139}_{57}\text{La} + x\,{}^{1}_{0}\text{n} + 7\,{}^{0}_{-1}\text{e}$$

(a) (i) Use the equation to determine the value of x.

x = ... [1]

(ii) State the name of the particle represented by the symbol ${}^{0}_{-1}e$.

.... [1]

(b) Some data for the nuclei in the reaction are given in Fig. 7.1.

	mass / u	binding energy per nucleon / MeV
uranium-235 (${}^{235}_{92}\text{U}$)	235.123	
molybdenum-95 (${}^{95}_{42}\text{Mo}$)	94.945	8.09
lanthanum-139 (${}^{139}_{57}\text{La}$)	138.955	7.92
proton (${}^{1}_{1}\text{p}$)	1.007	
neutron (${}^{1}_{0}\text{n}$)	1.009	

Fig. 7.1

Use data from Fig. 7.1 to

(i) determine the binding energy, in u, of a nucleus of uranium-235.

binding energy = ... u [3]

(ii) show that the binding energy per nucleon of a nucleus of uranium-235 is 7.18 MeV.

[3]

(c) The kinetic energy of the neutron before the reaction is negligible.
Use data from **(b)** to calculate the total energy, in MeV, released in this reaction.

energy = …………………………………… MeV [2]

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