OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE UNIT **2821**

PHYSICS A

Forces and Motion

FRIDAY 8 JUNE 2007 Morning

Time: 1 hour

Additional materials: Electronic calculator
Ruler (cm/mm)
Protractor

Candidate Name

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre Number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 60.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculation.

For Examiner's Use		
Qu.	**Max.**	**Mark**
1	**11**	
2	**8**	
3	**9**	
4	**8**	
5	**12**	
6	**12**	
Total	**60**	

This document consists of **16** printed pages.

[Turn over

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\mathrm{mol^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

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

refractive index, $n = \dfrac{1}{\sin C}$

capacitors in series, $\dfrac{1}{C} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \ldots$

capacitors in parallel, $C = C_1 + C_2 + \ldots$

capacitor discharge, $x = x_0 e^{-t/CR}$

pressure of an ideal gas, $p = \frac{1}{3}\dfrac{Nm}{V}\langle c^2 \rangle$

radioactive decay, $x = x_0 e^{-\lambda t}$

$t_{\frac{1}{2}} = \dfrac{0.693}{\lambda}$

critical density of matter in the Universe, $\rho_0 = \dfrac{3H_0^2}{8\pi G}$

relativity factor, $= \sqrt{(1 - \dfrac{v^2}{c^2})}$

current, $I = nAve$

nuclear radius, $r = r_0 A^{1/3}$

sound intensity level, $= 10 \lg \left(\dfrac{I}{I_0} \right)$

Answer **all** the questions.

1 Fig. 1.1 shows a vacuum cleaner of weight ***W*** being pushed with a force ***P***. The force ***P*** acts at 30° to the horizontal.

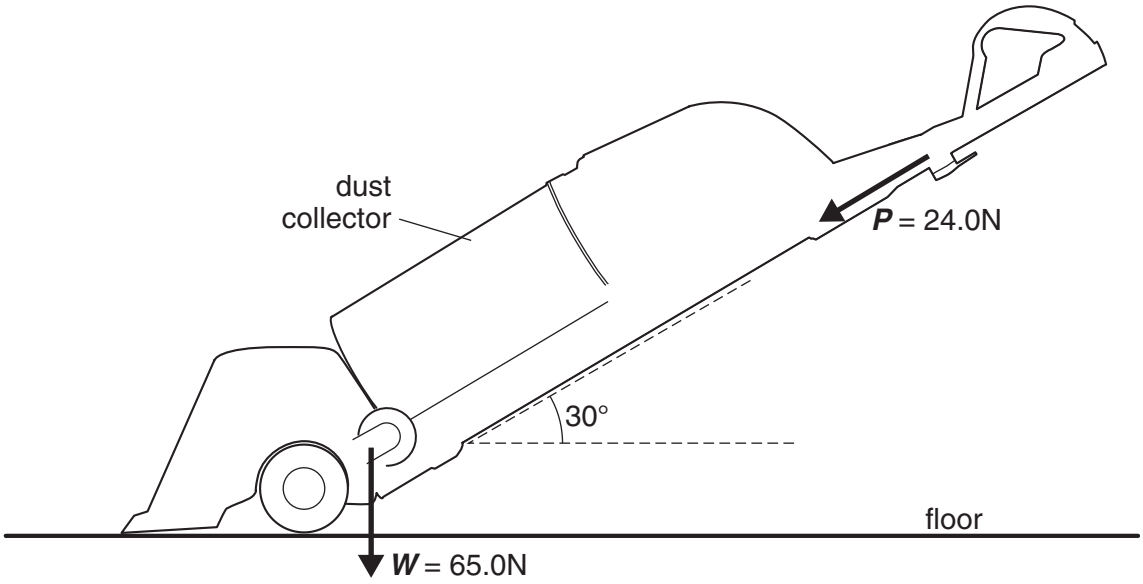

Fig. 1.1

The weight ***W*** is 65.0 N and the magnitude of force ***P*** is 24.0 N.

(a) (i) Calculate

1 the horizontal component of the force ***P***

horizontal component = ...N

2 the vertical component of the force ***P***.

vertical component = ...N [3]

(ii) Show that the total downward vertical force is 77.0 N.

[1]

(iii) Hence determine the magnitude of the resultant of the forces ***W*** and ***P***.

resultant force = ...N [2]

(iv) The vacuum cleaner is not switched on and is pushed in such a way that it travels at a constant velocity to the left. There are other forces acting on the vacuum cleaner. State and explain the magnitude of the resultant of these other forces.

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.....[2]

(b) (i) The total area of the vacuum cleaner in contact with the floor is 4.2×10^{-3} m^2. Calculate the pressure exerted on the floor by the total downward vertical force.

pressure = ...Pa [2]

(ii) State and explain what happens to this pressure if the handle is lifted so that its angle with the horizontal direction is more than 30°. The force ***P*** and the total area in contact with the floor remain constant.

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.....[1]

[Total: 11]

2 (a) Explain the term centre of gravity of an object.

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.....[2]

(b) Fig. 2.1 shows a lawn mower which is carried by two people.

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Details:

A diagram of a lawn mower

Fig. 2.1

(i) The two people apply forces A and B at each end of the lawn mower. The weight of the lawn mower is 350 N.

1 Explain why the weight of the lawn mower does not act in the middle of the lawn mower, that is 55 cm from each end.

.....

.....[1]

2 Use the principle of moments to show that the force ***B*** is 64 N.

[2]

3 Determine the force ***A***.

A = ...N [1]

(ii) State and explain what happens to the forces ***A*** and ***B*** if the person that applies force ***B*** moves his hands along the handle towards the middle of the lawn mower.

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.....[2]

[Total: 8]

3 Fig. 3.1 shows the path of a tennis ball after passing over the net.

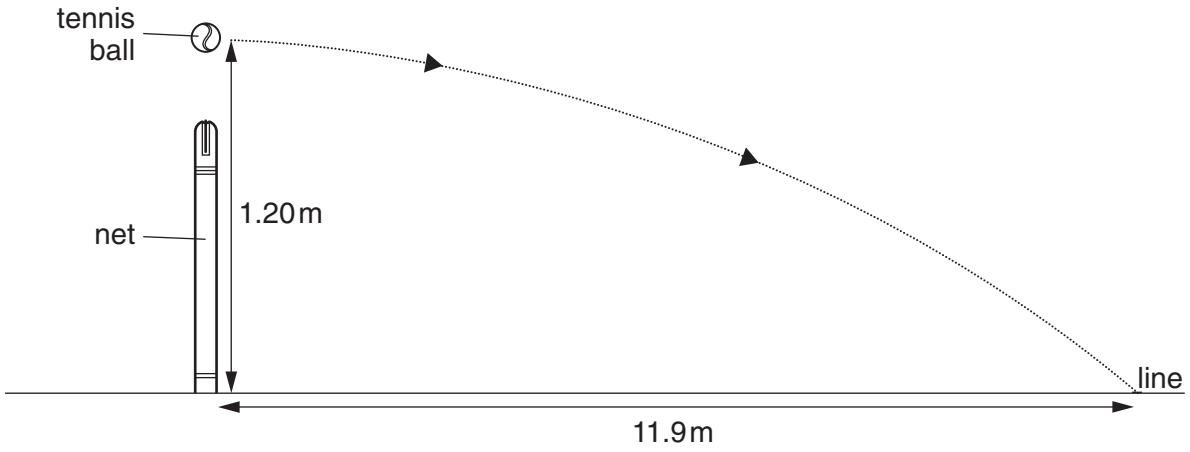

Fig. 3.1

As the ball passes over the net it is travelling horizontally at a height of 1.20 m. The ball strikes the ground on a line 11.9 m from the net.

(a) Assume that there is no air resistance acting on the ball.

(i) Show that the time taken for the ball to reach the line after passing over the net is 0.495 s.

[3]

(ii) At the instant the ball strikes the line calculate

1 the horizontal component of its velocity

horizontal component = ...m s^{-1} [2]

2 the vertical component of its velocity.

vertical component = ...m s^{-1} [2]

(b) The mass of the tennis ball is 6.00 x 10^{-2} kg. Calculate the loss in gravitational potential energy of the ball from the time it passes over the net until it hits the line.

loss in potential energy = ...J [2]

[Total: 9]

4 (a) Define the Young modulus .

.....

.....[1]

(b) Fig. 4.1 shows a violin.

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Details:

A diagram of a violin

Fig. 4.1

Two of the wires used on the violin, labelled A and G are made of steel. The two wires are both 500 mm long between the pegs and support. The 500 mm length of wire labelled G has a mass of 2.0 x 10^{-3} kg. The density of steel is 7.8 x 10^{3} kg m^{-3}.

(i) Show that the cross-sectional area of wire G is 5.1 x 10^{-7} m^2.

[2]

(ii) The wires are put under tension by turning the wooden pegs shown in Fig. 4.1. The Young modulus of steel is 2.0×10^{11} Pa.
Calculate the tension required in wire **G** to produce an extension of 4.0×10^{-4} m.

tension = ...N [3]

(iii) Wire **A** has a diameter that is half that of wire **G**. Determine the tension required for wire **A** to produce an extension of 16×10^{-4} m.

tension = ...N [1]

(iv) State the law that has been assumed in the calculations in **(ii)** and **(iii)**.

.....[1]

[Total: 8]

5 Fig. 5.1 shows a vehicle that is used for carrying people 'off-road'.

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Details:

An image of a 4x4 vehicle

Fig. 5.1

An off-road vehicle is designed so that it can be driven on rough and uneven ground. The mass of the vehicle and occupants is 3000 kg.

(a) Explain how the tyres are designed to reduce the pressure of the vehicle on the surface over which it is travelling.

.....

.....[1]

(b) The braking distance of the vehicle when travelling on a normal road at 26 m s $^{-1}$ is 52 m.

Calculate

(i) the kinetic energy of the vehicle and occupants before braking occurs

kinetic energy = ...J [3]

(ii) the average deceleration of the vehicle when braking

deceleration = ... unit..... [2]

(iii) the average braking force acting during the deceleration.

braking force = ...N [2]

(c) (i) State and explain how **two** different road conditions affect the braking distance of a car.

1. .....

.....

2. .....

.....[2]

(ii) The braking distance for a small car is shorter than for the off-road vehicle described above when they are tested travelling on the same road surface at the same speed. Discuss **one** difference between the small car and the off-road vehicle that could explain this.

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.....[2]

[Total: 12]

6 In this question, two marks are available for the quality of written communication.

A skydiver jumps from an aircraft that is flying horizontally at a height of 5000 m with a constant speed.

(a) Describe and explain the motion of the skydiver as she descends towards the ground from the moment she jumps until she opens her parachute. In your description of her motion use the terms speed, acceleration and force.

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(b) In some competitions the skydiver attempts to travel at the highest possible speed over a vertical distance of 1000 m. Discuss and explain the different methods that could be used by the skydiver to achieve the highest possible speed.

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.....[4]

Quality of Written Communication [2]

[Total: 12]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE