OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS A

Forces and Motion

2821

Friday **9 JUNE 2006** Morning 1 hour

Candidates answer on the question paper.
Additional materials:
Electronic calculator
Ruler (cm/mm)
Protractor

Candidate Name

Centre Number

Candidate Number

TIME 45 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre Number and Candidate number in the boxes above.
- Answer **all** the questions.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Write your answers, in blue or black ink, in the spaces provided on the question paper.
- Pencil may be used for graphs and diagrams only.
- Do not write in the bar code. Do not write in the grey area between the pages.
- **DO NOT** WRITE IN THE AREA **OUTSIDE** THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

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

FOR EXAMINER'S USE		
Qu.	Max	Mark
1	7	
2	8	
3	15	
4	7	
5	11	
6	12	
TOTAL	60	

This question paper consists of 14 printed pages and 2 blank 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, $n = \frac{1}{\sin C}$

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

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

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

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

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

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

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

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

current, $I = nAve$

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

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

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Answer **all** the questions.

1 **(a)** **(i)** Below is a list of five quantities. Underline those that are scalar quantities.

acceleration energy force power speed [1]

(ii) What is a vector quantity?

.....

.....[2]

(b) Fig. 1.1 shows the direction of two forces of 16 N and 12 N acting at an angle of 50° to each other.

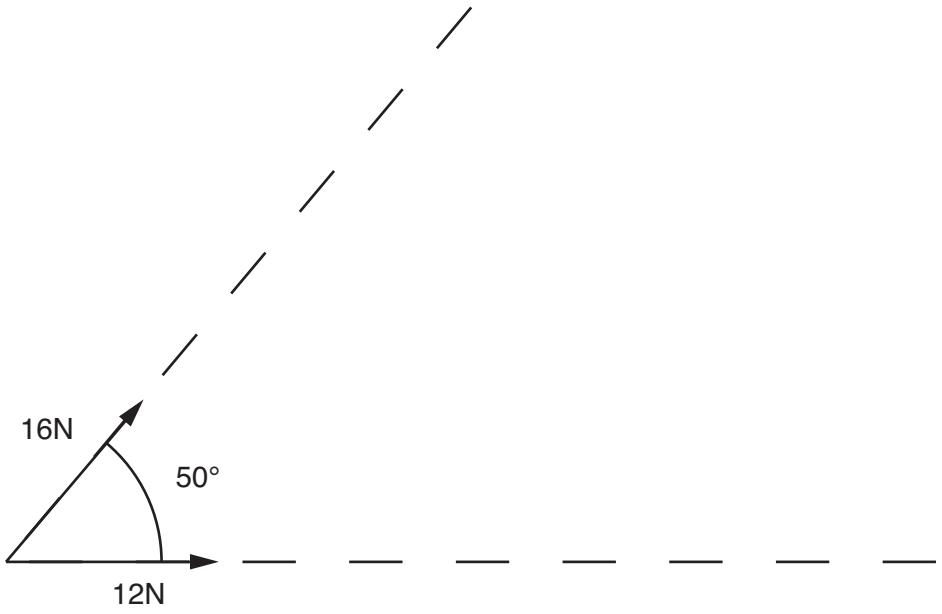

Fig. 1.1

Using Fig. 1.1, draw a vector diagram to determine the magnitude of the resultant of the two forces.

magnitude of resultant force ..... N [4]

[Total: 7]

2 Fig. 2.1 shows a gannet hovering above a water surface.

A diagram has been removed due to third party copyright restrictions

Details: A diagram of a gannet flying 30m above a water surface and a fish swimming 6m below the surface of the water

The gannet is 30 m above the water. It folds in its wings and falls vertically in order to catch a fish that is 6.0 m below the surface.

Ignore air resistance.

(a) Calculate

(i) the speed that the bird enters the water

speed = ... $m\,s^{-1}$ [2]

(ii) the time taken for the bird to fall to the water surface.

time = ... s [2]

(b) The bird does not continue to travel at the acceleration of free fall when it enters the water. State and explain the effect of the forces acting on the bird as it falls

(i) through the air

.....

.....

.....

.....[2]

(ii) through the water.

.....

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.....[2]

[Total: 8]

3 Fig. 3.1 shows the path of a ball that has been thrown by a girl towards a vertical wall.

Fig. 3.1

The girl throws the ball, of mass 5.0 $\times 10^{-2}$ kg, with a velocity of 10 ms^{-1} at 53° to the horizontal. In this question, ignore air resistance.

(a) (i) Show that the horizontal component of the velocity is 6.0 ms^{-1}.

[1]

(ii) In moving to the wall, the ball travels 4.9 m horizontally and 3.3 m vertically. Calculate the time taken for the ball to travel from the girl's hand to the wall.

time = ... s [2]

(iii) Calculate the gain in potential energy of the ball from leaving the girl's hand to when it hits the wall.

gain in potential energy = ... J [3]

(b) The ball is moving horizontally at $6.0\,m\,s^{-1}$ when it hits the wall. The ball is in contact with the wall for 0.16 s and rebounds horizontally at $4.0\,m\,s^{-1}$.
Calculate, for the time that the ball is in contact with the wall

(i) the change in velocity of the ball

change in velocity = ... m s^{-1} [1]

(ii) the horizontal acceleration of the ball (assumed to be constant)

acceleration = ... unit..... [2]

(iii) the horizontal force acting on the ball

magnitude of the force = ...N

direction of the force .....[3]

(iv) the loss in kinetic energy of the ball when rebounding from the wall.

loss in kinetic energy = ...J [3]

[Total: 15]

4 Fig. 4.1 shows two forces, each of magnitude 1200 N, acting on the edge of a disc of radius 0.20 m.

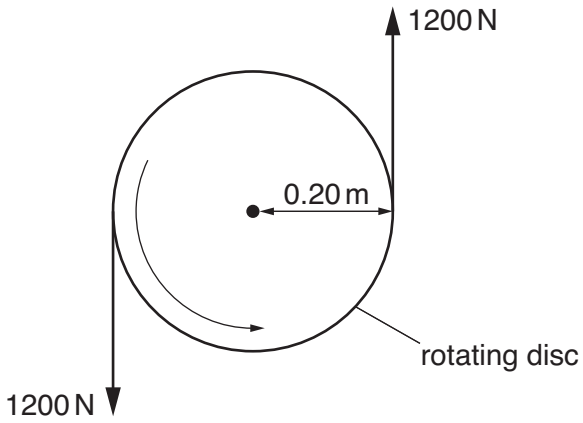

Fig. 4.1

(a) (i) Define the *torque of a couple*.

.....

.....[1]

(ii) Calculate the torque produced by these forces.

torque = ...N m [2]

(b) This torque is needed to overcome friction and keep the disc rotating at a constant rate.

(i) Show that the work done by the **two** forces when the disc rotates one complete revolution is about 3000 J.

[2]

(ii) Calculate the power required to keep the disc rotating at 40 revolutions per second.

power = ... W [2]

[Total: 7]

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5 Fig. 5.1 shows part of the force-extension graph for a spring. The spring obeys Hooke's law for forces up to 5.0 N.

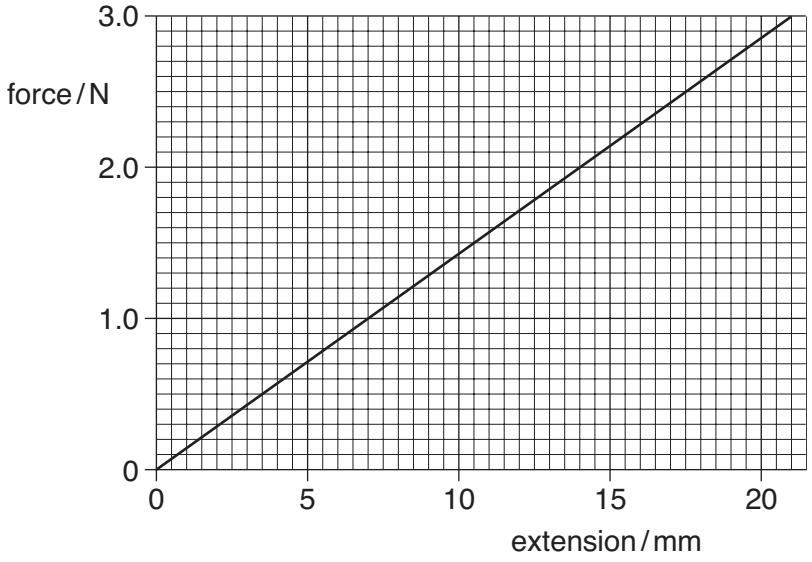

Fig. 5.1

(a) Calculate the extension produced by a force of 5.0 N.

extension = ...mm [2]

(b) Fig. 5.2 shows a second identical spring that has been put in parallel with the first spring A force of 5.0 N is applied to this combination of springs.

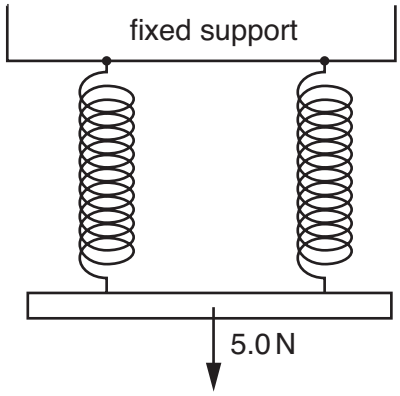

Fig. 5.2

For the arrangement shown in Fig. 5.2, calculate

(i) the extension of each spring

extension = ...mm [2]

(ii) the total strain energy stored in the springs.

strain energy = ...J [2]

(c) The Young modulus of the wire used in the springs is 2.0×10^{11} Pa. Each spring is made from a straight wire of length 0.40 m and cross-sectional area 2.0×10^{-7} m^2. Calculate the extension produced when a force of 5.0 N is applied to this straight wire.

extension = ...m [3]

(d) Describe and explain, without further calculations, the difference in the strain energies stored in the straight wire and in the spring when a 5.0 N force is applied to each.

.....

.....

.....[2]

[Total: 11]

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

(a) Explain the terms *motive force* and *braking force* when applied to motion of a vehicle. Discuss the forces acting on the tyre and the road at the point of contact with the road. Explain how changes in the magnitude and direction of the forces alter the acceleration of the vehicle.

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.....[5]

(b) State the factors that control the braking distance of a car. For each factor, explain the effect on the braking distance.

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.....[5]

Quality of Written Communication [2]

[Total: 12]

END OF QUESTION PAPER

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