27525201

OCR RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS A

2821

Forces and Motion

Monday **14 JUNE 2004** Afternoon 1 hour

Candidates answer on the question paper.
Additional materials:
Electronic calculator
Protractor
Ruler

Candidate Name

Centre Number

Candidate Number

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
  DO NOT ANSWER IN PENCIL. **DO NOT** WRITE IN THE BARCODE. **DO NOT** WRITE IN THE GREY AREAS BETWEEN THE PAGES.
- Read each question carefully and make sure you know what you have to do before starting your answer.

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	15	
2	13	
3	12	
4	10	
5	10	
TOTAL	60	

This question paper consists of 14 printed pages and 2 blank pages.

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.

For Examiner's Use

1 **(a)** Explain the difference between a *scalar* and *vector* quantity, including one example of each in your explanation.

(i) a scalar

....

....

(ii) a vector

....

....
[4]

(b) Fig. 1.1 shows the path of a car as it travels around a right-angled bend.

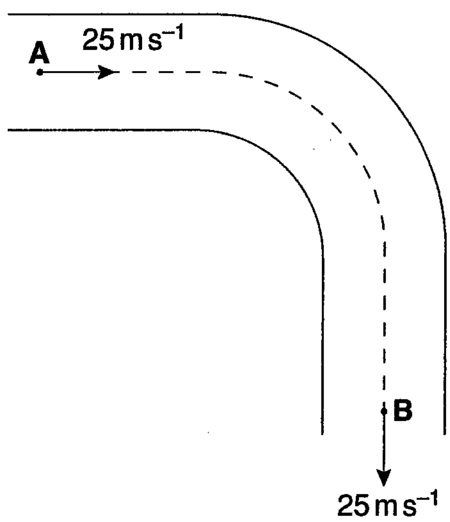

Fig. 1.1

The car travels from point **A** to point **B** in 7.6 s at a constant speed of $25\,m\,s^{-1}$.

(i) Calculate the distance the car travels in 7.6 s.

distance = ... m [2]

(ii) Draw a line on Fig. 1.1 to show the displacement of the car having travelled from **A** to **B**. [1]

For Examiner's Use

(iii) Explain why the velocity of the car changes as it travels from **A** to **B** although the speed remains constant.

....

....

.... [2]

(iv) Using a labelled vector triangle, calculate the magnitude of the change in velocity of the car (velocity at **B** – velocity at **A**).

magnitude of velocity change = ... $m\,s^{-1}$ [4]

(v) State and explain whether the car is accelerating as it travels around the bend from **A** to **B**.

....

....

.... [2]

[Total: 15]

For Examiner's Use

2 **(a)** Explain the quantities

(i) gravitational potential energy

....

....

.... [2]

(ii) kinetic energy

....

....

.... [2]

(iii) power.

....

....

.... [1]

(b) Water leaves a reservoir and falls through a vertical height of 130 m and causes a water wheel to rotate. The rotating wheel is then used to produce 110 kW of electrical power.

(i) Calculate the velocity of the water as it reaches the wheel, assuming that all the gravitational potential energy is converted to kinetic energy.

velocity = ... $m\,s^{-1}$ [3]

(ii) Calculate the mass of water flowing through the wheel per second, assuming that the production of electrical energy is 100% efficient.

mass of water per second = ... unit .... [3]

For Examiner's Use

(iii) State and explain **two** reasons why the mass of water flowing per second needs to be greater than the value in **(ii)** in order to produce this amount of electrical power.

....

....

....

.... [2]

[Total: 13]

For Examiner's Use

3 Fig. 3.1 shows a helicopter that has a cable hanging from it to the sea below.

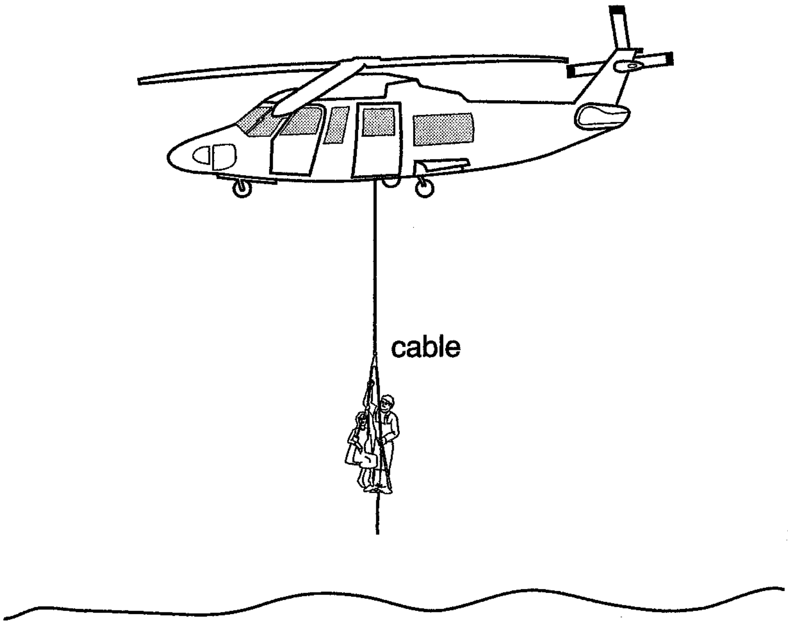

Fig. 3.1

A girl of mass 55 kg is rescued by a man of mass 75 kg. The two are attached to the cable and are lifted from the sea to the helicopter. The lifting process consists of an initial acceleration followed by a period of constant velocity and completed by a final deceleration.

(a) Name the **two** main forces acting on the two people being lifted.

....

.... [2]

(b) Calculate the combined weight of the man and girl.

weight = ... N [1]

(c) Calculate the tension in the cable during

(i) the initial acceleration of $0.55\,\text{m}\,\text{s}^{-2}$

tension = ... N [2]

For Examiner's Use

(ii) the period of constant velocity.

tension = ... N [2]

(d) Calculate the final deceleration if the tension in the cable is 1240 N.

deceleration = ... m s^{-2} [2]

(e) Sketch on Fig. 3.2 a graph of velocity *v* against time *t* for the complete lifting process. Numerical values are not required.

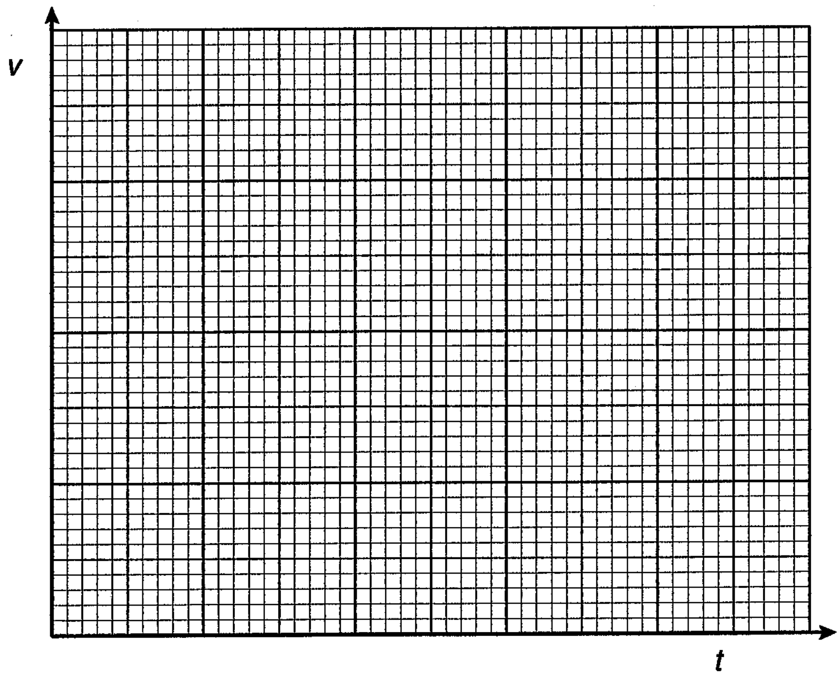

Fig. 3.2

[3]

[Total: 12]

For Examiner's Use

4 **(a)** Define the *Young modulus.*

....

.... [1]

(b) The wire used in a piano string is made from steel. The original length of wire used was 0.75 m. Fixing one end and applying a force to the other stretches the wire. The extension produced is 4.2 mm.

(i) Calculate the strain produced in the wire.

strain = ... [2]

(ii) The Young modulus of the steel is 2.0×10^{11} Pa and the cross-sectional area of the wire is 4.5×10^{-7} m^2. Calculate the force required to produce the strain in the wire calculated in **(i)**.

force = ... N [3]

(c) A different material is used for one of the other strings in the piano. It has the same length, cross-sectional area and force applied. Calculate the extension produced in this wire if the Young modulus of this material is half that of steel.

extension = ... mm [2]

For Examiner's Use

(d) **(i)** Define *density*.

....

.... [1]

(ii) State and explain what happens to the density of the material of a wire when it is stretched. Assume that when the wire stretches the cross-sectional area remains constant.

....

....

.... [1]

[Total: 10]

For Examiner's Use

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

(a) Describe how the driving wheels of a car can generate a motive force.

....

....

....

....

....

....

....

....

....

.... [4]

(b) Explain why friction is important in accelerating and decelerating a car.

In your answer

- discuss factors affecting the magnitude of the acceleration
- state the direction in which friction acts for both acceleration and deceleration.

....

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For Examiner's Use

[4]

Quality of Written Communication [2]

[Total: 10]

END OF QUESTION PAPER

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