THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE
PHYSICS A
Forces and Motion

2821

Candidates answer on the question paper

OCR Supplied Materials:
None

Other Materials Required:
- Electronic calculator
- Ruler
- Protractor

Tuesday 13 January 2009
Afternoon

Duration: 1 hour

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks 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 calculations.
- This document consists of **16** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**16**	
2	**8**	
3	**10**	
4	**6**	
5	**10**	
6	**10**	
TOTAL	**60**	

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,	$p = \frac{1}{3}\frac{Nm}{V}<c^2>$
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,	$= 10 \lg \left(\frac{I}{I_0}\right)$

Answer **all** the questions.

1 A projectile is fired, from ground level, into the air at a velocity of 50 m s^{-1} and 53° to the horizontal. Fig. 1.1 shows the variation of the vertical component of the velocity v_v against time, t, until the projectile reaches its maximum height at 4.1 s.

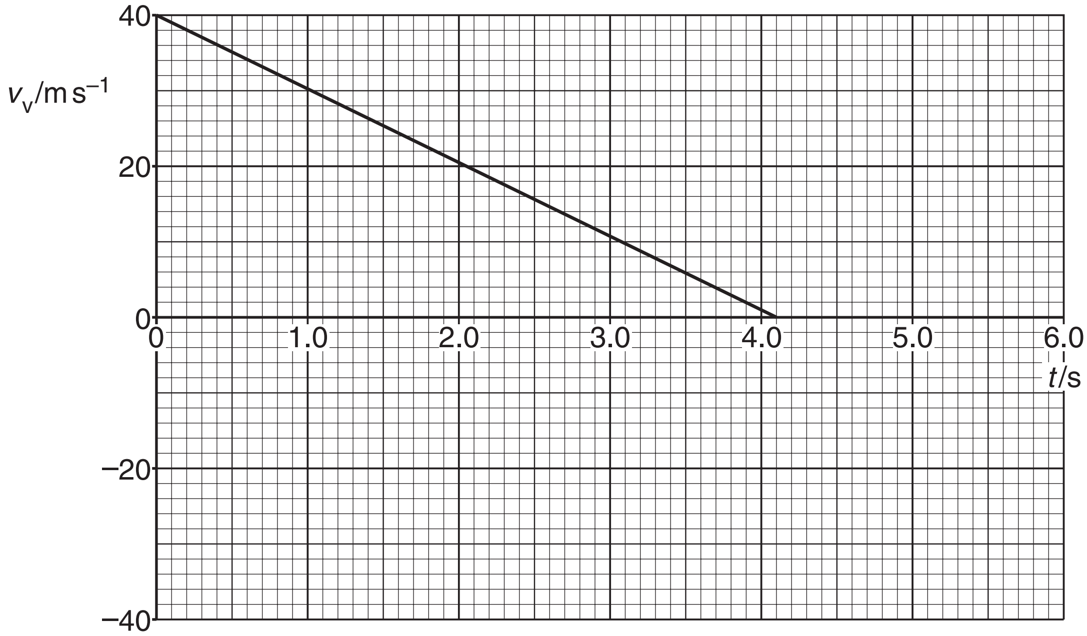

Fig. 1.1

Fig. 1.2 shows the variation of the horizontal component of the velocity v_h against time, t, for the same part of the journey.

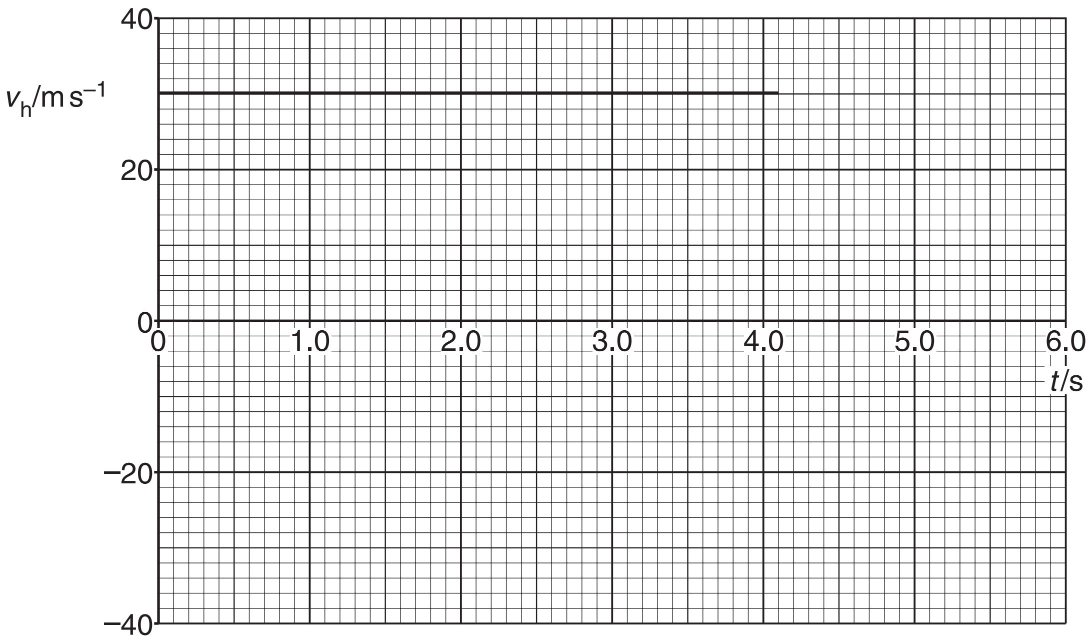

Fig. 1.2

(a) **(i)** Use Figs. 1.1 and 1.2 to describe the motion of the projectile

1 in the vertical direction

....

.... **[1]**

2 in the horizontal direction.

....

.... **[1]**

(ii) Use Figs. 1.1 and 1.2 to calculate at the maximum height

1 the vertical displacement

vertical displacement = ... m **[2]**

2 the horizontal displacement.

horizontal displacement = ... m **[1]**

(b) Describe the difference between the distance travelled by the projectile and the displacement of the projectile.

....

....

.... **[2]**

(c) **(i)** Use Figs. 1.1 and 1.2 to determine v_v and v_h after 2.0 s.

v_v = ... $m\,s^{-1}$

v_h = ... $m\,s^{-1}$ **[1]**

(ii) Hence or otherwise calculate the velocity of the projectile after 2.0 s.

magnitude of the velocity = ... $m\,s^{-1}$

angle of velocity to the horizontal = ...° **[4]**

(iii) State the magnitude of the velocity of the projectile after 4.1 s.

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

(d) Continue the graphs in Figs. 1.1 and 1.2 to show how the velocity of the projectile varies up to 6.0 s. **[3]**

[Total: 16]

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2 Fig. 2.1 shows apparatus used to determine the acceleration due to gravity.

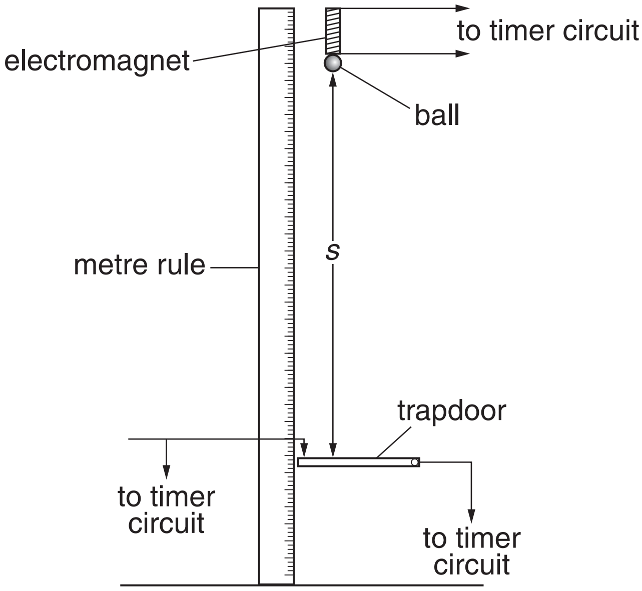

Fig. 2.1

A clock starts when a ball is released from an electromagnet and stops when the ball opens a trapdoor. The clock then displays the time t for the ball to fall a distance s. The trapdoor is moved to change the value of s. Fig. 2.2 shows the variation of t^2 against distance s.

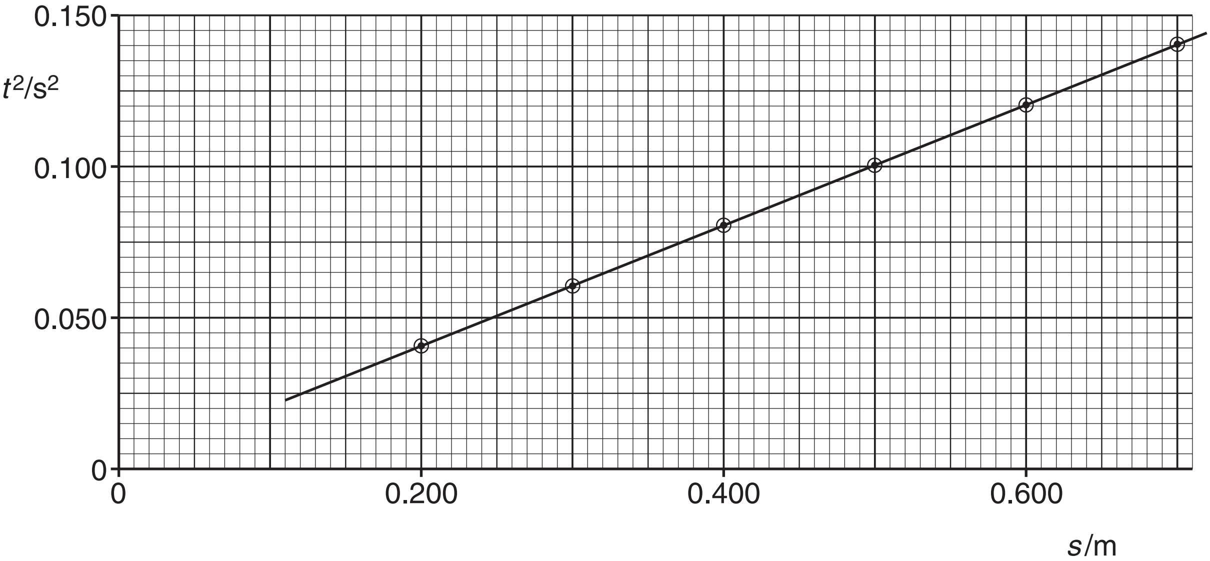

Fig. 2.2

(a) Use an equation of motion to explain why the graph in Fig. 2.2 is a straight line.

....

....

....

.... **[2]**

(b) Use Fig. 2.2 to calculate

(i) the gradient of the graph

gradient = ... **[2]**

(ii) the acceleration of the ball.

acceleration = ... $m\,s^{-2}$ **[2]**

(c) When a student performs this experiment he obtains a straight line graph which does not pass through the origin. Suggest **two** reasons why.

....

....

....

.... **[2]**

[Total: 8]

3 **(a)** Define

(i) the *newton*

....

.... **[1]**

(ii) *work done by a force*.

....

.... **[1]**

(b) A car of mass m is travelling at a speed u. A constant braking force F is applied until the car comes to rest. The car travels a distance s after the force is applied.

(i) Write equations for

1 the work done by the force F

2 the relationship between the force F and acceleration a.

[1]

(ii) Use the equations in **(i)** to show that the work done bringing the car to rest equals the loss in kinetic energy of the car.

[3]

(iii) Hence describe the relationship between the braking distance and the velocity of a car.

....

....

.... **[1]**

(c) (i) A car of mass 1550 kg has a braking distance of 25.0 m when travelling at 13.3 $m\,s^{-1}$. Calculate the average braking force acting on the car.

force = ... N **[2]**

(ii) Deduce the braking distance when the car is travelling at 26.6 $m\,s^{-1}$ and the same braking force is applied.

distance = ... m **[1]**

[Total: 10]

4 **(a)** **(i)** Define *pressure*.

....

.... **[1]**

(ii) Define *density*.

....

.... **[1]**

(b) Fig. 4.1 shows the outline of a swimming pool that is on the top floor of a building.

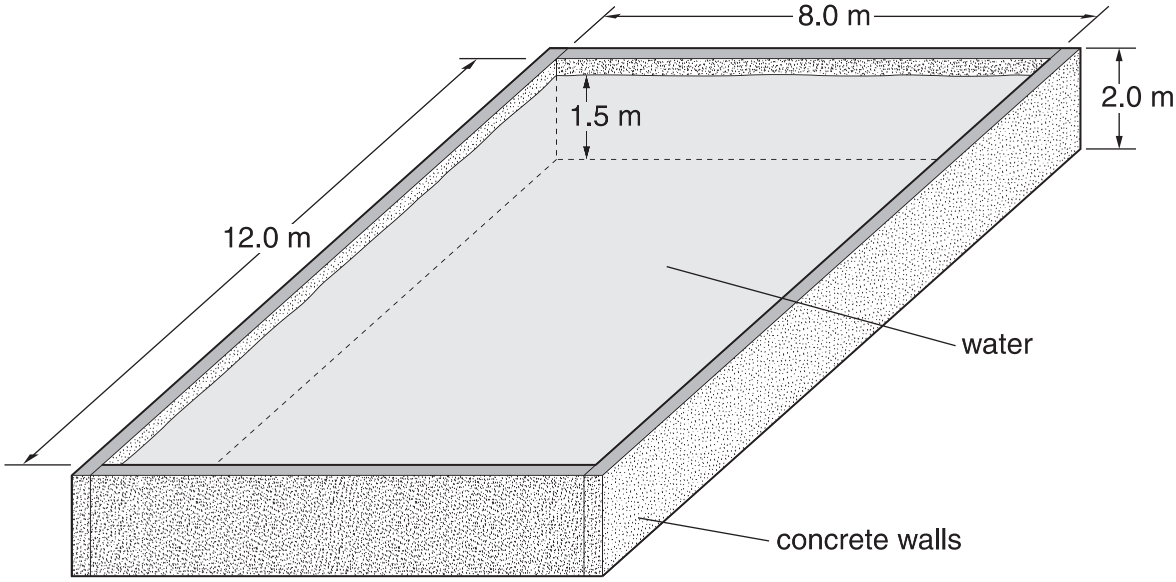

Fig. 4.1

The total volume of concrete used is 27 m^3. The density of the concrete is 2600 kg m^{-3}.

(i) Calculate the mass of concrete.

mass = ... kg **[1]**

(ii) The pool contains water to a constant depth of 1.5 m. The internal dimensions of the pool are 8.0 m by 12.0 m. The density of water is 1000 kg m^{-3}.
Calculate the pressure the water exerts on the base of the pool.

pressure = ... Pa **[2]**

(iii) Suggest with a reason whether the pressure on the floor under the concrete walls or under the water is greater.

....

....

.... **[1]**

[Total: 6]

5 **(a)** Define the *centre of gravity* of a body.

....

.... **[1]**

Fig. 5.1 shows a boat being lifted vertically. It is attached to two ropes labelled **1** and **2**. A motor lifts the boat vertically.

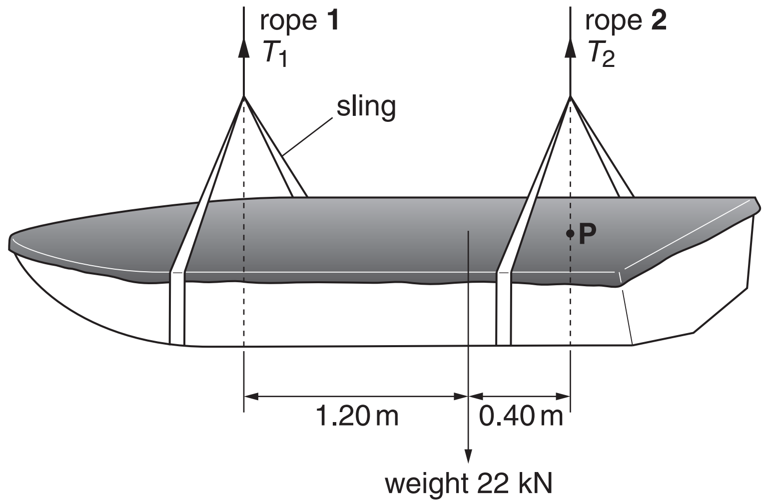

Fig. 5.1

(b) When the boat is rising at a constant speed the tensions in ropes **1** and **2** are T_1 and T_2 respectively. The weight of the boat is 22 kN. The weight acts 1.20 m and 0.40 m from the lines of action of the tensions T_1 and T_2 respectively.

(i) Explain why the rising boat can be described as being in equilibrium.

....

.... **[1]**

(ii) Calculate the moment of the weight of the boat about the point **P**.

moment = ... unit .... **[2]**

(iii) Calculate the tension T_1.

T_1 = ... N **[2]**

(iv) Calculate the tension T_2.

T_2 = ... N **[1]**

(v) Calculate the minimum power required by the motor to lift the boat at a constant speed of $0.015\,m\,s^{-1}$.

power = ...W **[2]**

(c) Describe and explain one situation during the lifting of the boat when it will not be in equilibrium.

....

.... **[1]**

[Total: 10]

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

(a) Use the following terms to explain the behaviour of a spring when a tensile force is applied:

extension **Hooke's law** **elastic limit** **spring constant**

....

....

....

....

....

....

....

.... **[3]**

THIS QUESTION CONTINUES ON PAGE 16

(b) Describe how the following terms may be used to compare materials:

stiff **strong** **brittle** **ductile**

In your answer you should include the quantities stress, strain and Young modulus and the terms elastic and plastic.

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.... **[5]**

Quality of Written Communication **[2]**

[Total: 10]

END OF QUESTION PAPER