



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
 General Certificate of Education  
 Advanced Subsidiary Level and Advanced Level

CANDIDATE  
NAME

CENTRE  
NUMBER

--	--	--	--	--

CANDIDATE  
NUMBER

--	--	--	--



**PHYSICS**

**9702/23**

Paper 2 AS Structured Questions

**October/November 2011**

**1 hour**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

You may lose marks if you do not show your working or if you do not use appropriate units.

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	
2	
3	
4	
5	
6	
<b>Total</b>	

This document consists of **15** printed pages and **1** blank page.



**Data**

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

**Formulae**

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
simple harmonic motion,	$a = -\omega^2 x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel,	$C = C_1 + C_2 + \dots$
energy of charged capacitor,	$W = \frac{1}{2} QV$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$
alternating current/voltage,	$x = x_0 \sin \omega t$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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

For  
Examiner's  
Use

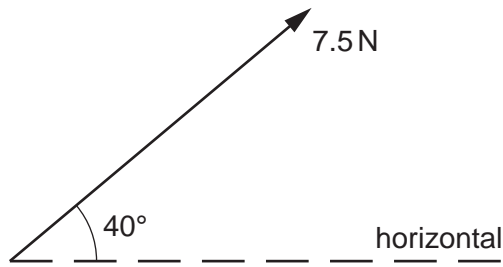
1 (a) Distinguish between scalars and vectors.

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

(b) Underline **all** the vector quantities in the list below.

acceleration      kinetic energy      momentum      power      weight      [2]

(c) A force of 7.5N acts at 40° to the horizontal, as shown in Fig. 1.1.



**Fig. 1.1**

Calculate the component of the force that acts

(i) horizontally,

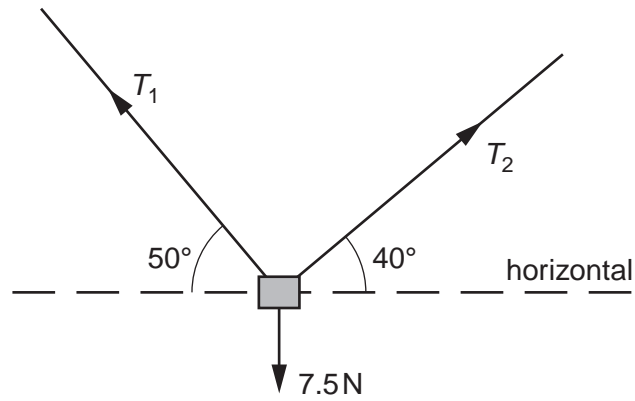
horizontal component = ..... N [1]

(ii) vertically.

vertical component = ..... N [1]

- (d) Two strings support a load of weight 7.5 N, as shown in Fig. 1.2.

For  
Examiner's  
Use



**Fig. 1.2**

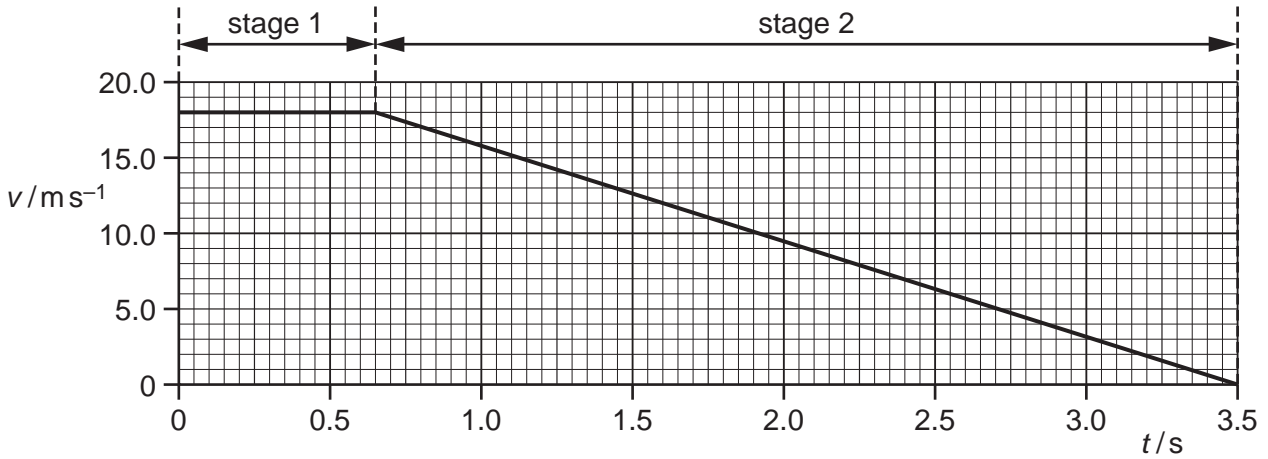
One string has a tension  $T_1$  and is at an angle  $50^\circ$  to the horizontal. The other string has a tension  $T_2$  and is at an angle  $40^\circ$  to the horizontal. The object is in equilibrium. Determine the values of  $T_1$  and  $T_2$  by using a vector triangle or by resolving forces.

$$T_1 = \dots\dots\dots \text{ N}$$

$$T_2 = \dots\dots\dots \text{ N}$$

[4]

2 The variation with time  $t$  of velocity  $v$  of a car is shown in Fig. 2.1.



**Fig. 2.1**

At time  $t = 0$ , the driver sees an obstacle in the road. A short time later, the driver applies the brakes. The car travels in two stages, as shown in Fig. 2.1.

(a) Use Fig. 2.1 to describe the velocity of the car in

1. stage 1,

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

2. stage 2.

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

(b) (i) Calculate the distance travelled by the car from  $t = 0$  to  $t = 3.5$  s.

total distance = ..... m [2]

- (ii) The car has a total mass of 1250 kg. Determine the total resistive force acting on the car in stage 2.

For  
Examiner's  
Use

force = ..... N [3]

- (c) For safety reasons drivers are asked to travel at lower speeds. For each stage, describe and explain the effect on the distance travelled for the same car and driver travelling at half the initial speed shown in Fig. 2.1.

- (i) stage 1:

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

- (ii) stage 2:

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

3 (a) Define the terms

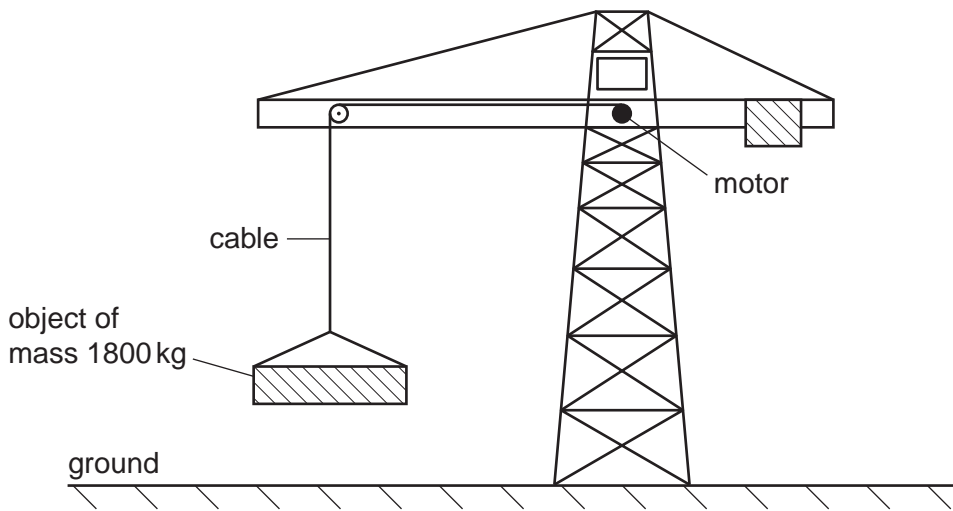
(i) *power*,

..... [1]

(ii) the *Young modulus*.

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

(b) A crane is used to lift heavy objects, as shown in Fig. 3.1.



**Fig. 3.1**

The motor in the crane lifts a total mass of 1800 kg from rest on the ground. The cable supporting the mass is made of steel of Young modulus  $2.4 \times 10^{11}$  Pa. The cross-sectional area of the cable is  $1.3 \times 10^{-4}$  m<sup>2</sup>. As the mass leaves the ground, the strain in the cable is 0.0010. Assume the weight of the cable to be negligible.

(i) 1. Use the Young Modulus of the steel to show that the tension in the cable is  $3.1 \times 10^4$  N.

[2]

2. Calculate the acceleration of the mass as it is lifted from the ground.

acceleration = ..... ms<sup>-2</sup> [3]



- (ii) The motor now lifts the mass through a height of 15 m at a constant speed.

Calculate

1. the tension in the lifting cable,

tension = ..... N [1]

2. the gain in potential energy of the mass.

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

- (iii) The motor of the crane is 30% efficient. Calculate the input power to the motor required to lift the mass at a constant speed of  $0.55 \text{ m s}^{-1}$ .

input power = ..... W [3]

For  
Examiner's  
Use

- 4 (a) Distinguish between *potential difference* (p.d.) and *electromotive force* (e.m.f.) in terms of energy transformations.

For  
Examiner's  
Use

.....

.....

.....

..... [2]

- (b) Two cells A and B are connected in series with a resistor R of resistance  $5.5\ \Omega$ , as shown in Fig. 4.1.

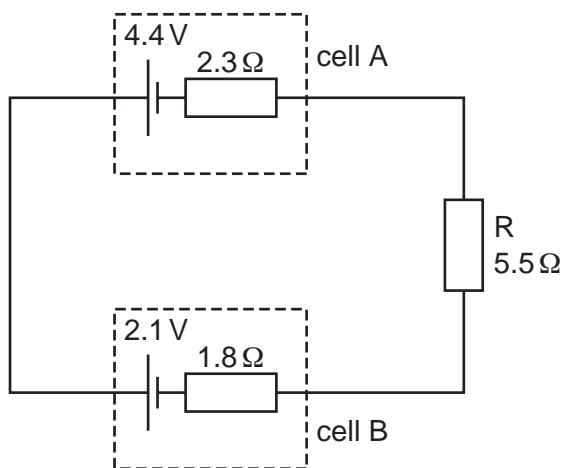


Fig. 4.1

Cell A has e.m.f. 4.4V and internal resistance  $2.3\ \Omega$ . Cell B has e.m.f. 2.1V and internal resistance  $1.8\ \Omega$ .

- (i) State Kirchhoff's second law.

.....

..... [1]

- (ii) Calculate the current in the circuit.

current = ..... A [2]

- (iii) On Fig. 4.1, draw an arrow to show the direction of the current in the circuit. Label this arrow *I*. [1]

(iv) Calculate

1. the p.d. across resistor R,

p.d. = ..... V [1]

2. the terminal p.d. across cell A,

p.d. = ..... V [1]

3. the terminal p.d. across cell B.

p.d. = ..... V [2]

For  
Examiner's  
Use

- 5 (a) By reference to vibrations of the points on a wave and to its direction of energy transfer, distinguish between transverse waves and longitudinal waves.

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

- (b) Describe what is meant by a *polarised* wave.

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

- (c) The variation with distance  $x$  of the displacement  $y$  of a transverse wave is shown in Fig. 5.1.

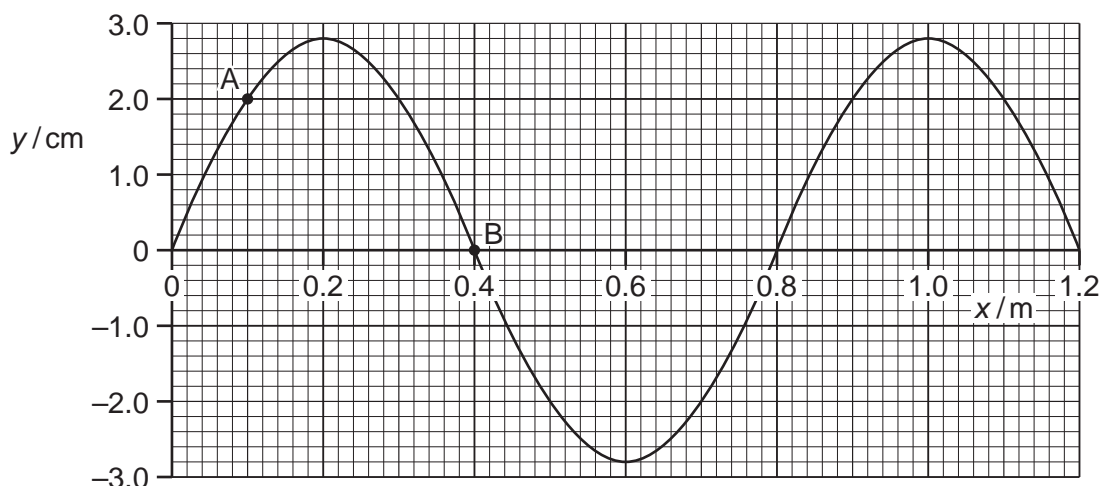


Fig. 5.1

- (i) Use Fig. 5.1 to determine

1. the amplitude of the wave,

amplitude = ..... cm [1]

2. the phase difference between the points labelled A and B.

phase difference = ..... [2]

- (ii) Determine the amplitude of a wave with twice the intensity of that shown in Fig. 5.1.

*For  
Examiner's  
Use*

amplitude = ..... cm [1]

- 6 Two horizontal metal plates are separated by distance  $d$  in a vacuum. A potential difference  $V$  is applied across the plates, as shown in Fig. 6.1.

For  
Examiner's  
Use

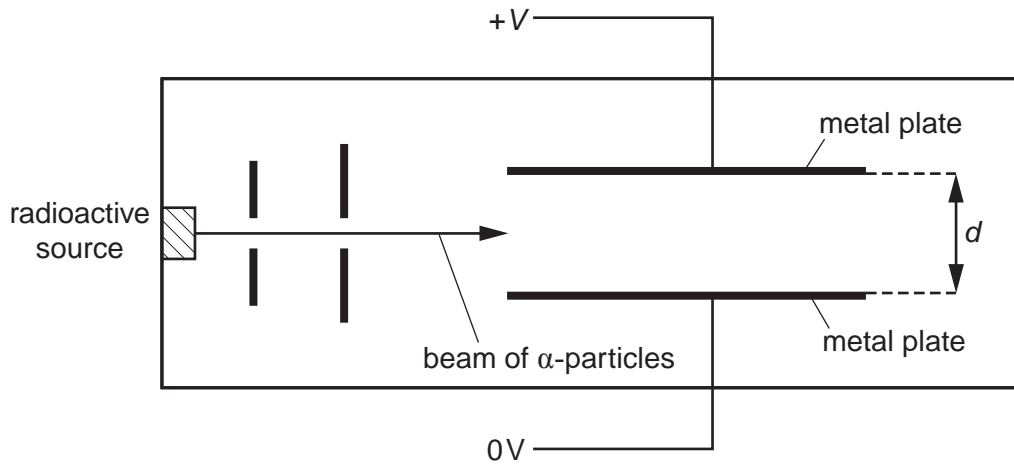


Fig. 6.1

A horizontal beam of  $\alpha$ -particles from a radioactive source is made to pass between the plates.

- (a) State and explain the effect on the deflection of the  $\alpha$ -particles for each of the following changes:

- (i) The magnitude of  $V$  is increased.

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

- (ii) The separation  $d$  of the plates is decreased.

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

(b) The source of  $\alpha$ -particles is replaced with a source of  $\beta$ -particles. Compare, with a reason in each case, the effect of each of the following properties on the deflections of  $\alpha$ - and  $\beta$ -particles in a uniform electric field:

(i) charge

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

(ii) mass

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

(iii) speed

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

(c) The electric field gives rise to an acceleration of the  $\alpha$ -particles and the  $\beta$ -particles. Determine the ratio

$$\frac{\text{acceleration of the } \alpha\text{-particles}}{\text{acceleration of the } \beta\text{-particles}}$$

ratio = ..... [3]

**BLANK PAGE**

---

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.