Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

1100096837

PHYSICS **9702/23**

Paper 2 AS Level Structured Questions **May/June 2020**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Blank pages are indicated.

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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	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
	$(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1})$
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 unit	$1\,\text{u} = 1.66 \times 10^{-27}\,\text{kg}$
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	$g = 9.81\,\text{m s}^{-2}$

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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.	$v = v_0 \cos \omega t$ $v = \pm \omega\sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel	$C = C_1 + C_2 + \ldots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_0 \sin \omega t$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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[Turn over

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

1 **(a)** State **one** similarity and **one** difference between *distance* and *displacement*.

similarity: .....

.....

difference: .....

.....

[2]

(b) A student takes several measurements of the same quantity. This set of measurements has high precision, but low accuracy.

Describe what is meant by:

(i) *high precision*

.....

..... [1]

(ii) *low accuracy*.

.....

..... [1]

[Total: 4]

2 **(a)** State Newton's first law of motion.

.....

..... [1]

(b) A skier is pulled in a straight line along horizontal ground by a wire attached to a kite, as shown in Fig. 2.1.

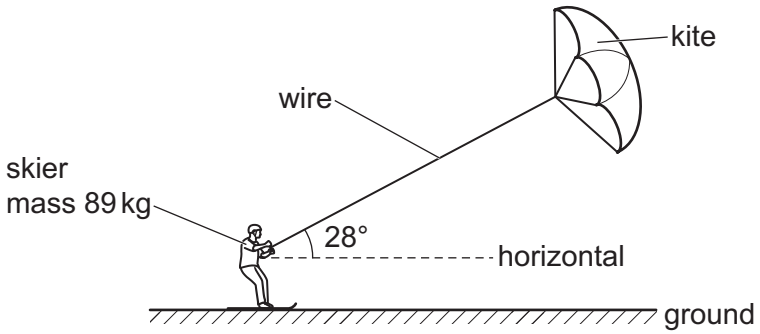

Fig. 2.1 (not to scale)

The mass of the skier is 89 kg. The wire is at an angle of 28° to the horizontal. The variation with time t of the velocity v of the skier is shown in Fig. 2.2.

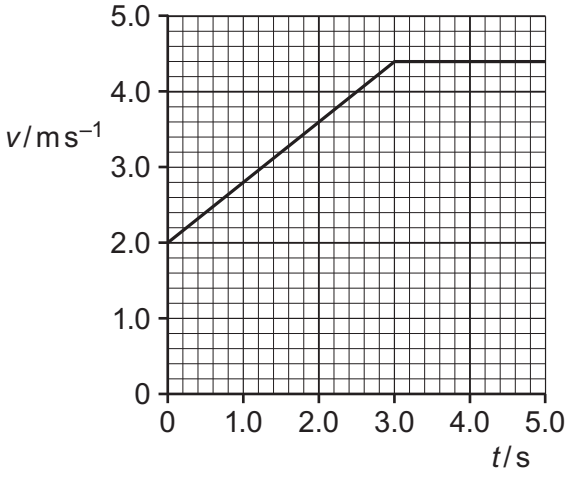

Fig. 2.2

(i) Use Fig. 2.2 to determine the distance moved by the skier from time t = 0 to t = 5.0 s.

distance = ... m [2]

(ii) Use Fig. 2.2 to show that the acceleration a of the skier is $0.80\,m\,s^{-2}$ at time $t = 2.0\,s$.

[2]

(iii) The tension in the wire at time $t = 2.0\,s$ is 240 N.

Calculate:

1. the horizontal component of the tension force acting on the skier

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

2. the total resistive force R acting on the skier in the horizontal direction.

R = ... N [2]

(iv) The skier is now lifted upwards by a gust of wind. For a few seconds the skier moves horizontally through the air with the wire at an angle of 45° to the horizontal, as shown in Fig. 2.3.

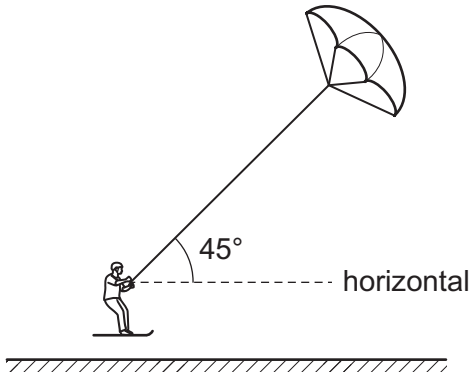

Fig. 2.3 (not to scale)

By considering the vertical components of the forces acting on the skier, determine the new tension in the wire when the skier is moving horizontally through the air.

tension = ... N [2]

[Total: 10]

3 **(a)** State the principle of moments.

.....

.....

..... [2]

(b) In a bicycle shop, two wheels hang from a horizontal uniform rod AC, as shown in Fig. 3.1.

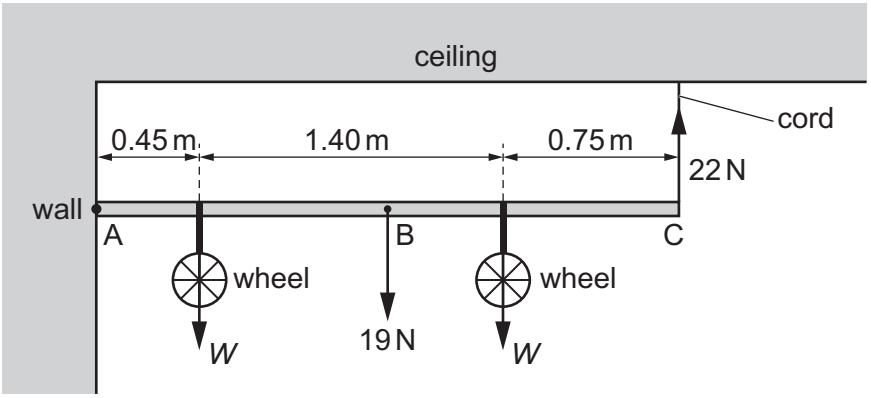

Fig. 3.1 (not to scale)

The rod has weight 19 N and is freely hinged to a wall at end A. The other end C of the rod is attached by a vertical elastic cord to the ceiling. The centre of gravity of the rod is at point B. The weight of each wheel is *W* and the tension in the cord is 22 N.

(i) By taking moments about end A, show that the weight *W* of each wheel is 14 N.

[2]

(ii) Determine the magnitude and the direction of the force acting on the rod at end A.

magnitude = ... N

direction .....

[2]

(c) The unstretched length of the cord in **(b)** is 0.25 m. The variation with length L of the tension F in the cord is shown in Fig. 3.2.

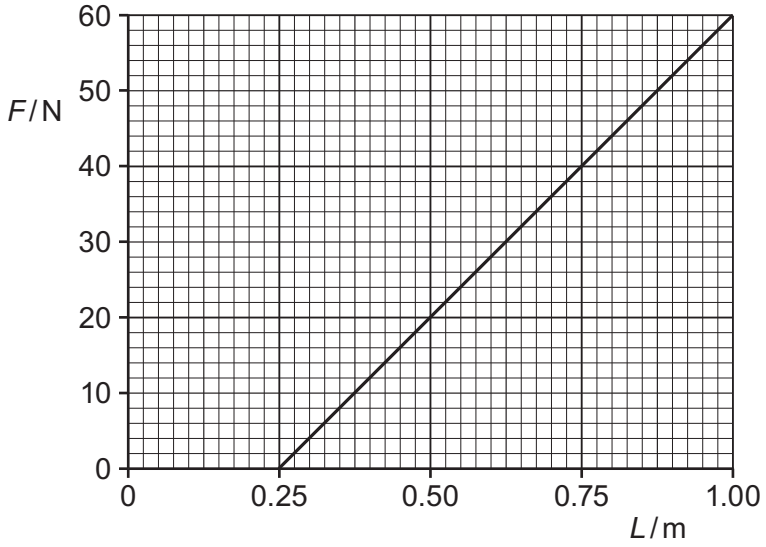

Fig. 3.2

(i) State and explain whether Fig. 3.2 suggests that the cord obeys Hooke's law.

.....

.....

..... [2]

(ii) Calculate the spring constant k of the cord.

k = ... $N\,m^{-1}$ [2]

(iii) On Fig. 3.2, shade the area that represents the work done to extend the cord when the tension is increased from $F = 0$ to $F = 40$ N. [1]

[Total: 11]

4 Two progressive sound waves Y and Z meet at a fixed point P. The variation with time t of the displacement x of each wave at point P is shown in Fig. 4.1.

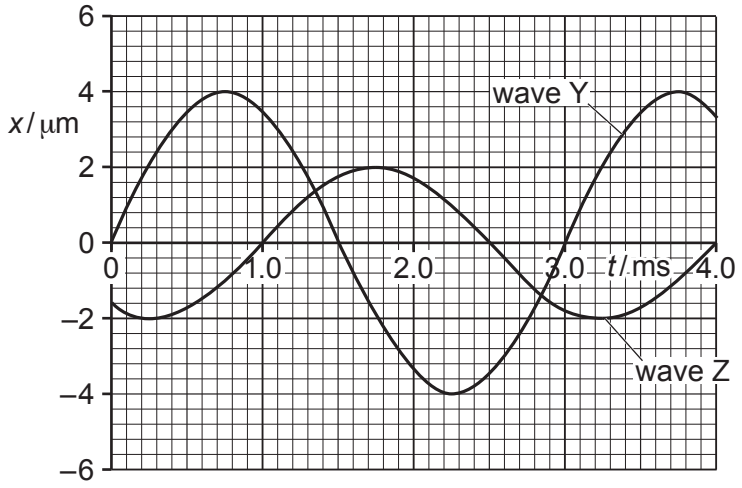

Fig. 4.1

(a) Use Fig. 4.1 to state **one** quantity of waves Y and Z that is:

(i) the same

..... [1]

(ii) different.

..... [1]

(b) State and explain whether waves Y and Z are coherent.

.....

..... [1]

(c) Determine the phase difference between the waves.

phase difference = ... ° [1]

(d) The two waves superpose at P. Use Fig. 4.1 to determine the resultant displacement at time t = 0.75 ms.

resultant displacement = ... μm [1]

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(e) The intensity of wave Y at point P is I.

Determine, in terms of I, the intensity of wave Z.

intensity = ... [2]

(f) The speed of wave Z is $330\,m\,s^{-1}$.

Determine the wavelength of wave Z.

wavelength = ... m [3]

[Total: 10]

5 **(a)** Define the *volt*.

.....

..... [1]

(b) Fig. 5.1 shows a network of three resistors.

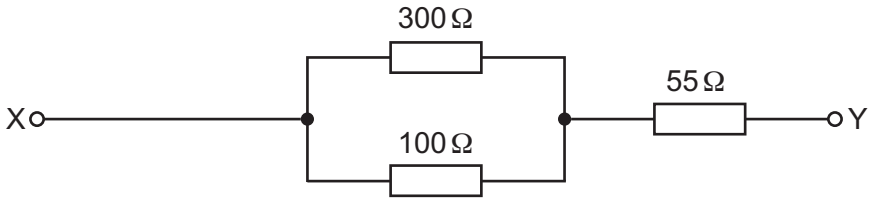

Fig. 5.1

Calculate:

(i) the combined resistance of the two resistors connected in parallel

combined resistance = ... Ω [1]

(ii) the total resistance between terminals X and Y.

total resistance = ... Ω [1]

(c) The network in **(b)** is connected to a power supply so that there is a potential difference between terminals X and Y. The power dissipated in the resistor of resistance 55 Ω is 0.20 W.

(i) Calculate the current in the resistor of resistance:

1. 55 Ω

current = ... A

2. 300 Ω.

current = ... A
[3]

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(ii) Calculate the potential difference between X and Y.

potential difference = ... V [1]

[Total: 7]

6 The current I in a metal wire is given by the expression

$$I = Anve$$

where v is the average drift speed of the free electrons in the wire and e is the elementary charge.

(a) State what is meant by the symbols A and n.

A: .....

n: .....
[2]

(b) Use the above expression to determine the SI base units of e.
Show your working.

base units ..... [2]

(c) Two lamps P and Q are connected in series to a battery, as shown in Fig. 6.1.

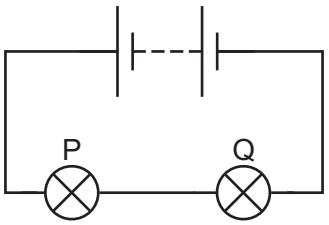

Fig. 6.1

The radius of the filament wire of lamp P is twice the radius of the filament wire of lamp Q. The filament wires are made of metals with the same value of n.

Calculate the ratio

$$\frac{\text{average drift speed of free electrons in filament wire of P}}{\text{average drift speed of free electrons in filament wire of Q}}.$$

ratio = ... [2]

[Total: 6]

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7 A potential difference is applied between two horizontal metal plates that are a distance of 6.0 mm apart in a vacuum, as shown in Fig. 7.1.

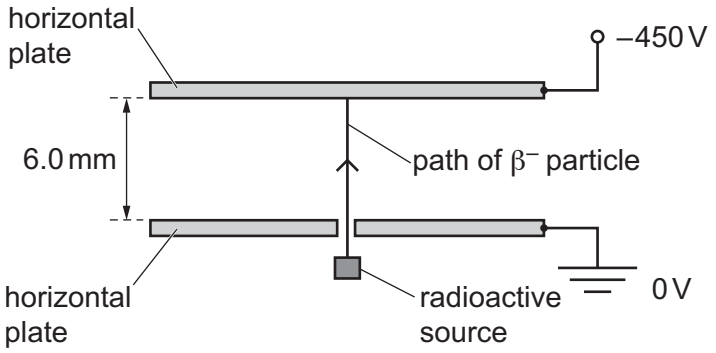

Fig. 7.1

The top plate has a potential of –450 V and the bottom plate is earthed. Assume that there is a uniform electric field produced between the plates.

A radioactive source emits a β^- particle that travels through a hole in the bottom plate and along a vertical path until it reaches the top plate.

(a) (i) Determine the magnitude and the direction of the electric force acting on the β^- particle as it moves between the plates.

magnitude of force = ... N

direction of force .....
[4]

(ii) Calculate the work done by the electric field on the β^- particle for its movement from the bottom plate to the top plate.

work done = ... J [2]

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(b) The β^- particle is emitted from the source with a kinetic energy of 3.4×10^{-16} J.

Calculate the speed at which the β^- particle is emitted.

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

(c) The β^- particle is produced by the decay of a neutron.

(i) Complete the equation below to represent the decay of the neutron.

$$^{1}_{0}n \rightarrow {}^{0}_{-1}\beta^- + {}^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots + {}^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots$$

[2]

(ii) State the name of the group (class) of particles that includes:

1. neutrons

.....

2. β^- particles.

.....

[2]

[Total: 12]

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