EUNOIA JUNIOR COLLEGE
JC1 Promotional Examination 2019
General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME								
CIVICS GROUP	1	9	-			REGISTRATION NUMBER		

PHYSICS

9749/02

Paper 2 Structured Questions

04 October 2019

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

The use of an approved scientific calculator is expected where appropriate.

Answer **all** questions.

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	
7	
S.F.	
Total	

This document consists of **20** printed pages

Data

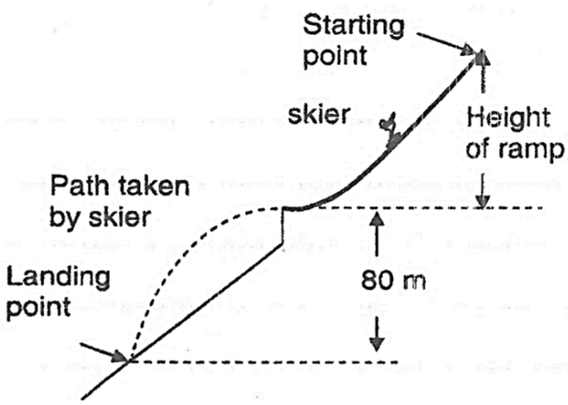
speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_o	=	8.85×10^{-12} F m^{-1}
			$(1/(36\,\pi)) \times 10^{-9}$ F m^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
molar gas constant,	R	=	8.31 J K^{-1} mol^{-1}
the Avogadro constant,	N_A	=	6.02×10^{23} mol^{-1}
the Boltzmann constant,	k	=	1.38×10^{-23} J K^{-1}
gravitational constant,	G	=	6.67×10^{-11} N m^{2} kg^{-2}
acceleration of free fall,	g	=	9.81 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	=	$p\Delta V$
hydrostatic pressure,	p	=	ρgh
gravitational potential,	ϕ	=	$-\dfrac{Gm}{r}$
temperature,	T/K	=	T / °C + 273.15
pressure of an ideal gas,	p	=	$\dfrac{1}{3}\dfrac{Nm}{V}\langle c^2\rangle$
mean translational kinetic energy of an ideal gas molecule	E	=	$\dfrac{3}{2}kT$
displacement of particle in s.h.m.	x	=	$x_o \sin \omega t$
velocity of particle in s.h.m.	v	=	$v_o \cos \omega t$
		=	$\pm\, \omega\sqrt{\left(x_o{}^2 - x^2\right)}$
electric current,	I	=	$Anvq$
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$
electric potential,	V	=	$\dfrac{Q}{4\pi\varepsilon_o r}$
alternating current/voltage,	x	=	$x_o \sin \omega t$
magnetic flux density due to a long straight wire	B	=	$\dfrac{\mu_o I}{2\pi d}$
magnetic flux density due to a flat circular coil	B	=	$\dfrac{\mu_o NI}{2r}$
magnetic flux density due to a long solenoid	B	=	$\mu_o nI$
radioactive decay,	x	=	$x_o \exp(-\lambda t)$
decay constant	λ	=	$\dfrac{\ln 2}{t_{\frac{1}{2}}}$

1 Fig. 1.1 shows a skier of mass 80 kg descending the ramp of a ski jump and leaving the ramp horizontally.

Fig. 1.2 shows a graph of the distance travelled along the ramp against time, from the time the descent starts until the skier leaves the end of the ramp.



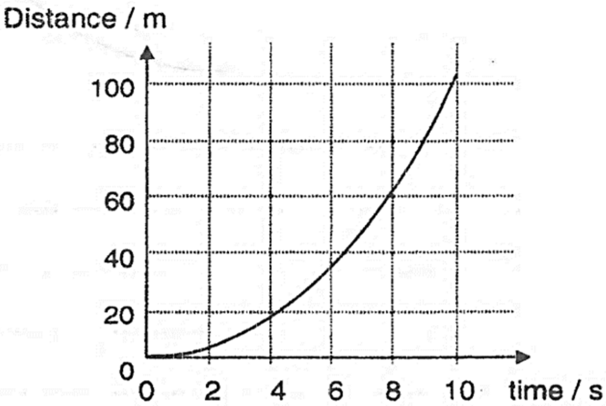


Fig. 1.1 **Fig. 1.2**

(a) **(i)** Using Fig. 1.2, determine the speed at which the skier leaves the ramp.

speed = ………………………....... m s^{-1} [2]

(ii) The skier gains 55% of the available gravitational potential energy as kinetic energy when descending the ramp.

Determine the height of the ramp.

height = ………………………....... m [2]

(b) **(i)** On Fig. 1.3, draw all the forces acting on the skier at that instance. [1]

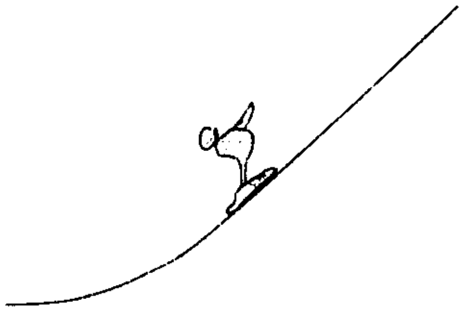


Fig. 1.3

(ii) Hence explain the shape of the graph shown in Fig. 1.2.

....

....

....

.... [2]

(c) Assuming that there is no lift or drag due to the air after the skier leaves the ramp, calculate

(i) the time for which the skier was in flight,

time = ………………………...... s [1]

(ii) the horizontal distance travelled by the skier before landing.

distance = ………………………...... m [1]

2 **(a)** **(i)** Define *linear momentum*.

....

.... [1]

(ii) State the *Principle of Conservation of Momentum*.

....

....

.... [1]

(b) A firework of mass 0.30 kg is launched with an initial velocity *v* of 8.0 m s^{-1} at an angle of 60° to the ground, which is horizontal. It explodes at P, the maximum height of its trajectory. Fig. 2.1 shows the path of the firework from the point of projection O to P.

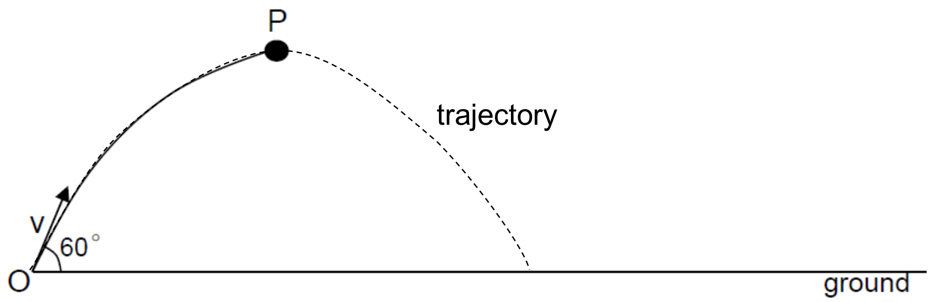


Fig. 2.1

At the instant when the firework is at P, an internal explosion separates it into two parts, X and Y of masses 0.20 kg and 0.10 kg respectively.

Immediately after the explosion, X is moves horizontally backwards at 4 m s^{-1} while Y moves horizontally forward.

Assume that the effect of air resistance is negligible for the whole process.

(i) Show that the speed of Y is 20 m s^{-1} immediately after the explosion.

[2]

(ii) Calculate the impulse experienced by Y.

impulse = ... N s [2]

(iii) A student estimates that the explosive force acts on Y for 1 ms. Calculate the force acting on Y in this situation.

force = ………………………........ N [2]

(c) Determine the energy released in the explosion.

energy released = ………………………........ J [3]

(d) On Fig 2.1, sketch the new path of the firework if air resistance was not negligible. Indicate the top of the trajectory **P’** clearly. [1]

3 An electric hotplate designed to operate on a power supply of 240 V has two coils of wire of resistivity of $9.8 \times 10^{-7}\ \Omega$ m. Each coil of wire has a length of 16 m and cross-sectional area 0.20 mm^2.

(a) For one of the coils, calculate

(i) its resistance, and

resistance = …………………………..... Ω [2]

(ii) the power dissipated when a 240 V supply is connected across it.

power = …………………………..... W [2]

(b) Fig. 3.1 shows how the two coils can be connected to operate at different power outputs.

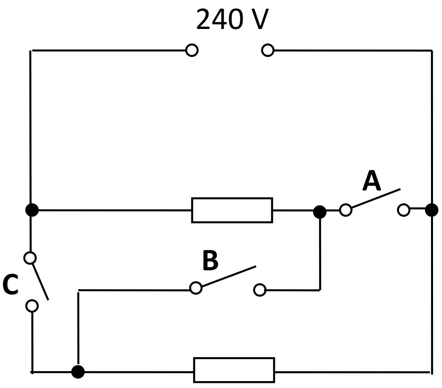


Fig. 3.1

Complete Table 3.1 below with either "ON" or "OFF" for each of the switches A, B and C to obtain the lowest and highest levels of operating power without incurring a short circuit.

Table 3.1

	switch A	switch B	switch C
Lowest			
Highest			

[2]

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4 (a) Explain what is meant by the *angular frequency* of an oscillation.

....

.... [1]

(b) A thin metal strip is clamped at one end so that it is horizontal. A load of mass M is attached to its free end. The load causes a displacement s of the end of the strip as shown in Fig. 4.1.

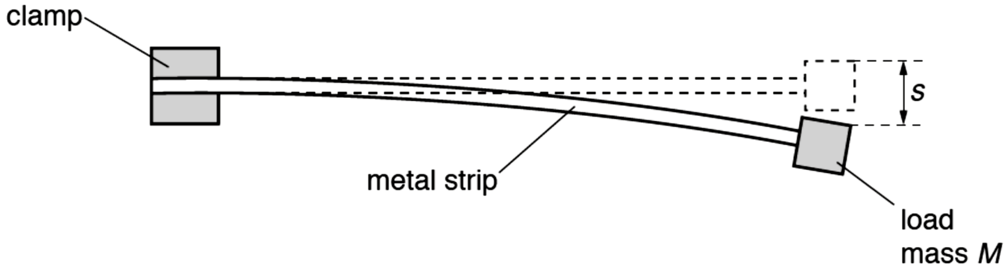

Fig. 4.1

The load is displaced vertically and then released. The load oscillates. The variation of the displacement s with the acceleration a of the load is shown in Fig. 4.2.

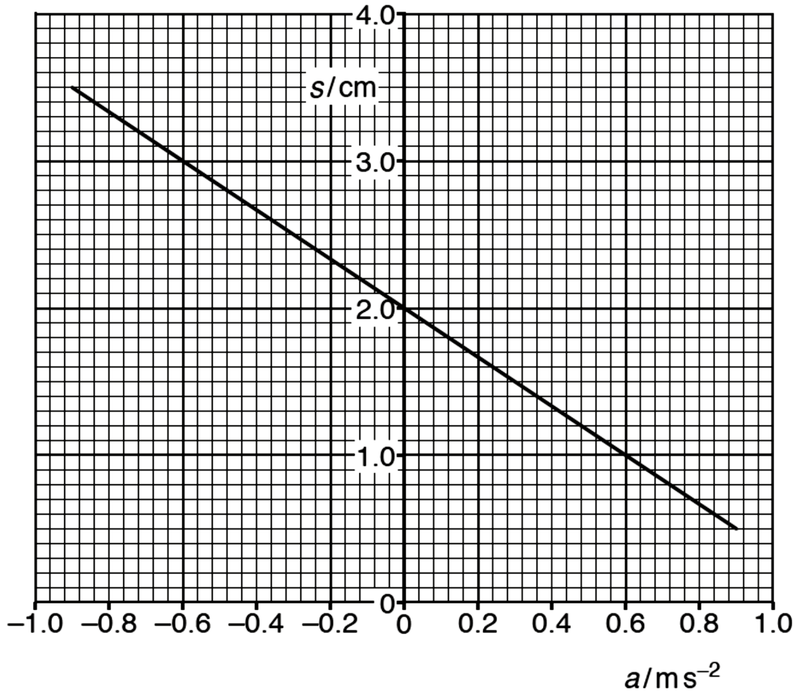

Fig. 4.2

(i) Use Fig. 4.2 to determine

1. the displacement of the load before it is made to oscillate, and

displacement = ... cm [1]

2. the amplitude of the oscillation of the load.

amplitude = ... cm [1]

(ii) Show that the load is undergoing simple harmonic motion.

....

....

....

....

.... [3]

(iii) Calculate

1. the frequency of oscillation of the load, and

frequency = ………………………… Hz [3]

2. the maximum speed of the load.

maximum speed = ………………………… m s^{-1} [1]

(c) Over a certain interval of time, the maximum kinetic energy of the oscillations in **(b)** is reduced by 25 %. It may be assumed that there is negligible change in angular frequency of the oscillation.

Determine the amplitude of oscillation.

amplitude = ………………………… cm [2]

5 **(a)** A space shuttle of mass m_s is launched from planet A of mass m_A and radius R_A to planet B of mass m_B and radius R_B. It travels along the line joining the centres of the planets.

The distance between the centres of mass of the planets is x and m_A is smaller than m_B,

(i) Write down an expression for the gravitational potential energy U_s of the shuttle in terms of G, m_s, m_A, m_B, x, and r when it is at a distance r from the centre of mass of planet A.

.... [1]

(ii) Sketch a labelled graph of U_s against r.

[2]

(iii) Using your graph in **(ii)**, state and explain how the gravitational force F_s on the shuttle varies with r.

....

....

....

....

.... [3]

(b) An asteroid S_1 of mass m moves with speed v in a circular orbit of radius a around the Earth of mass M.

(i) Show that its kinetic energy is equal to $-\dfrac{1}{2}$ times its gravitational potential energy.

[2]

(ii) Write down an expression for its total energy in terms of G, M, m and a.

.... [1]

(iii) A second asteroid S_2, of mass $2m$ but of the same total energy as S_1, moves in an elliptical orbit as shown in Fig. 5.1 below. Its distance of closest approach to the centre of the Earth BE is $a/2$. The distance EC is $3a/2$.

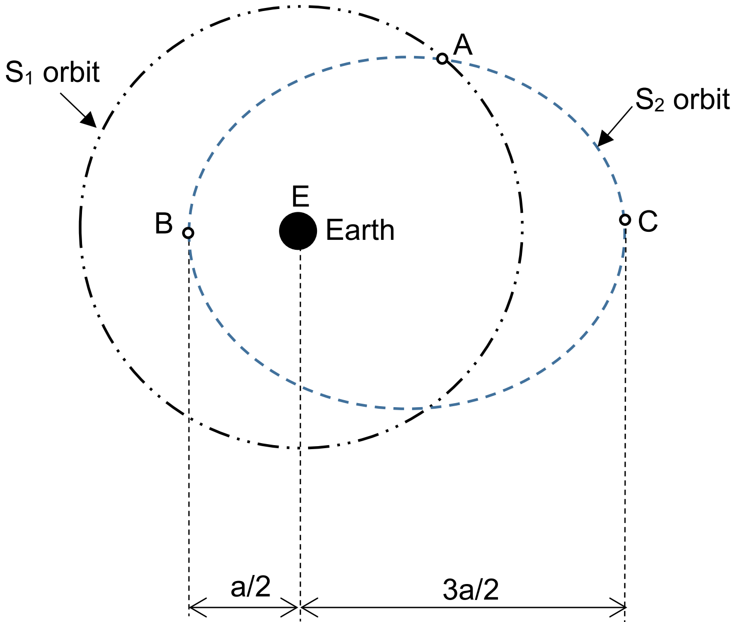

Fig. 5.1

Determine the speed of S_2, in terms of G, M and a

1. at A, and

speed of S_2 at A = ... [2]

2. at C.

speed of S_2 at C = ... [2]

6 A company rents out tower cranes of many different sizes. A tower crane is illustrated in Fig. 6.1. This type of tower crane is called a flat-top tower crane because the jib and counter jib are horizontal. A tower crane can be constructed to different arrangements of height, jib and counter-jib length, and balancing load.

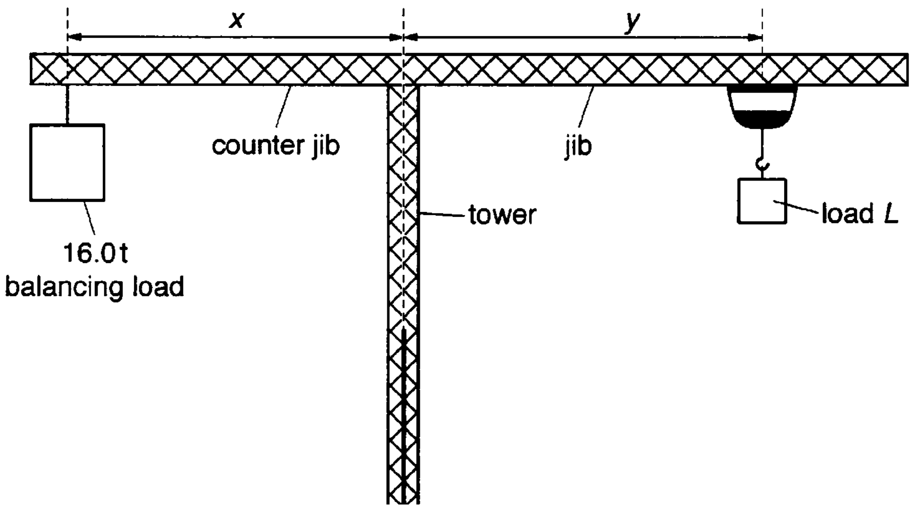

Fig. 6.1

Distance x is the fixed distance. This is a different distance for each different crane arrangement. Distance y is variable and changes as the load L is moved in and out from the tower, along the jib.

Table 6.1 lists information for three different crane arrangements.

Table 6.1

crane arrangement	total length of jib and counter jib / m	distance x to 16.0 t balancing load / m	maximum load L at different distances y / t		
			y = 30 m	y = 52 m	y = 75 m
A	95.0	17.3	8.48	4.31	2.60
B	75.0	19.4	9.79	5.15	-
C	55.0	22.3	11.53	-	-

The maximum load L in tonnes that can be lifted for different distances y from the centre of the tower for each arrangement is also shown.

Note: The masses of the loads in Fig. 6.1 and in Table 6.1 are given in tonnes (t).
One tonne is 1000 kg.

(a) **(i)** Calculate the weight of the 16.0 t balancing load.

weight = …………………… unit .... [2]

(ii) Using the data in Table 6.1, explain why there is no detail provided for crane C when y = 52 m.

....

....

.... [1]

(b) **(i)** Show, by considering the moments about the centreline of the tower, that the load and the balancing load given in the table can never put crane A in equilibrium.

....

....

.... [3]

(ii) When in use, crane A is in equilibrium. Suggest how this is achieved.

....

....

....

.... [2]

7 **(a)** Explain what is meant by two *coherent* waves.

....

.... [1]

(b) A sound system has two speakers S_1 and S_2 connected to the same source and placed at a distance of 1.2 m apart as shown in Fig 7.1.

Fig. 7.1

A microphone D is moved along the line XAY where A is equidistant from S_1 and S_2.

The speaker S_1 emits a signal that arrives at point A with intensity I and the speaker S_2 emits a signal that arrives at point A with intensity $4I$. Both speakers emit sound of frequency 2.8 kHz at a speed of 336 m s^{-1}.

(i) Determine the intensity of the sound detected at A in terms of I.

intensity = …………………………..... [3]

(ii) B is at a distance 3.72 m from S_1 and 4.02 m from S_2.

State and explain whether the microphone receives a maximum or a minimum signal at B.

....

....

....

.... [3]

(iii) The microphone is now fixed at point B. The frequency of the sound source is gradually increased.

Describe and explain how the sound detected fluctuates.

....

....

....

....

....

....

....

....

.... [3]

(c) A diffraction grating with 250 lines per mm is placed in front of a monochromatic red laser. A screen placed 200 cm beyond the grating has red images measured at certain positions on a scale on the screen, as shown in Fig 7.2.

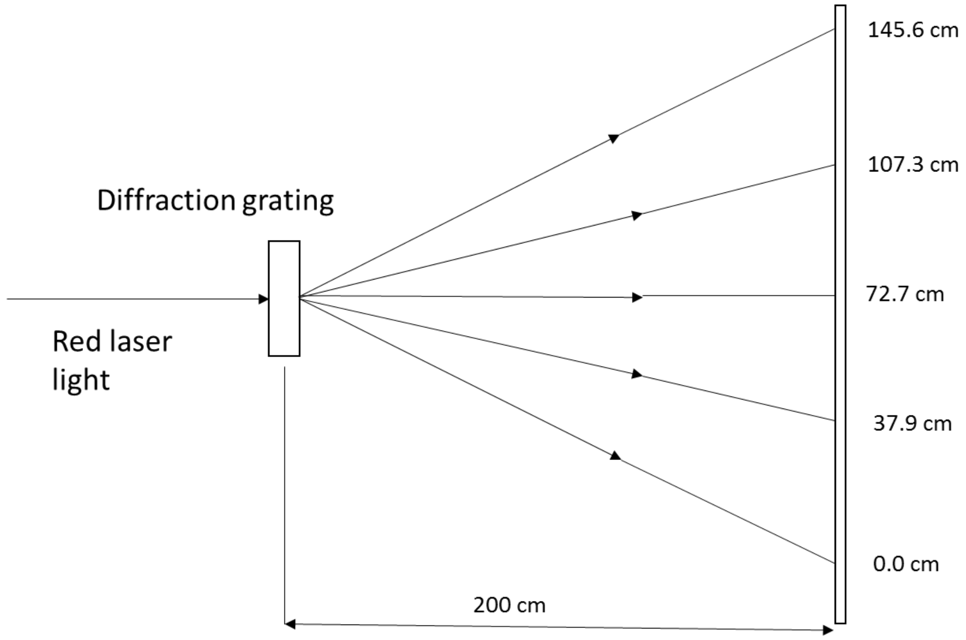

Fig. 7.2

(i) Determine the wavelength emitted by the laser.

wavelength = ………………………....... m [3]

(ii) In reality, the red laser is not monochromatic but instead has a small range of frequencies of red light. Suggest what would be observed on the screen.

....

.... [1]

(iii) State and explain any changes, other than the colour, to the pattern formed on the screen if a blue laser light is used.

....

....

.... [2]

(d) A stationary wave set up in a particular string fixed at both ends can only have modes of vibration such that a point Q at a quarter of its length from one end is a point of maximum vibration.

The lowest frequency possible is 100 Hz.

Determine the next higher frequency when a stationary wave is again set up such that Q is a point of maximum vibration.

frequency = ……….……………...... Hz [4]

End of Paper

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