Name: ____________________________ Class: 13S __________

VICTORIA JUNIOR COLLEGE
2014 JC2 PRELIMINARY EXAMINATION

PHYSICS **8866/2**
Higher 1
Paper 2

23/9/2014 **1400h – 1600h**
TUESDAY **(2 Hours)**

This paper consists of two sections:

Section A (40 marks) consists of 5 short structured questions. Write your answers in the spaces provided for each question.

Section B (40 marks) consists of 3 long structured questions. Answer ***any*** two questions. Write your answers in the spaces provided for each of the chosen questions.

The intended marks for each question or part question in sections A and B are given in brackets [ ].

N.B. You will hand in the whole question set issued to you at the end of the examination. Do not separate the question set into parts.

For marker's use	
Section A	
Q1	
Q2	
Q3	
Q4	
Q5	
Section B	
Q6	
Q7	
Q8	
s.f.	
units	
Total (80)	

This question set consists of a total of 18 printed pages.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	$e = 1.60 \times 10^{-19}$ C
the Planck constant,	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron,	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton,	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall,	$g = 9.81$ m s^{-2}

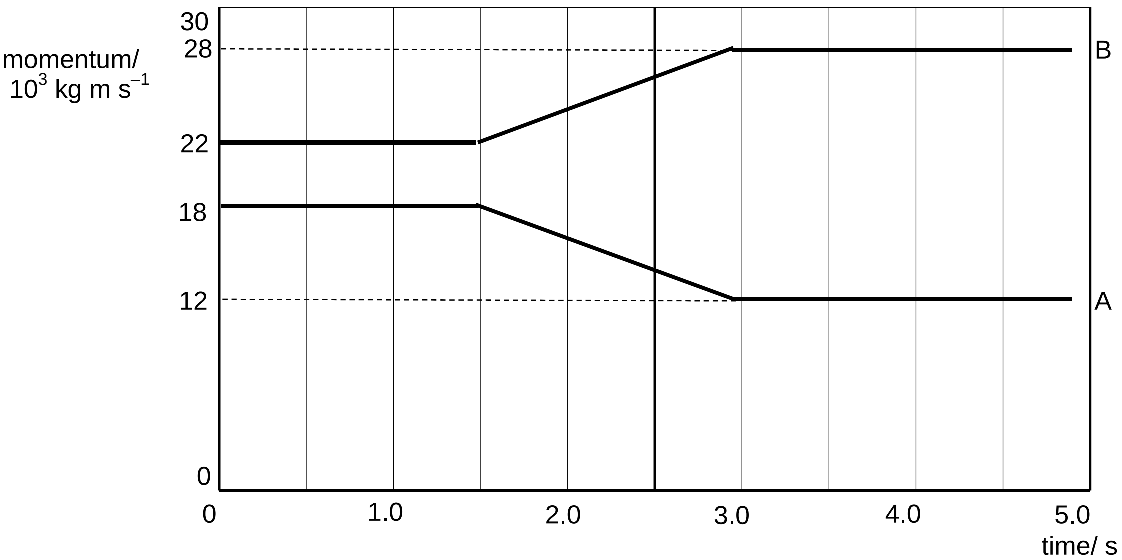
Formulae

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,	$p = h\rho g$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** the questions in this section.

1 The graph below shows the momentum against time graphs for two colliding lorries A and B.



The masses of lorries A and B are 2.0×10^3 kg and 4.0×10^3 kg respectively.

(a) State what the gradients of the graphs during the collision represent. [1]

(b) Explain why the gradients of the graphs during the collision have *opposite* signs. [1]

(c) Calculate the force acting on lorry B during the collision. Hence, or otherwise, calculate the force acting on lorry A during the collision. [2]

(d) Use Newton's laws of motion to explain whether momentum is conserved in this collision. [3]

2 (a) Distinguish between electrical resistance and resistivity. [4]

(b) The Nile fish (*Gnathonemus*) is capable of producing an electric field in the water around itself (refer to the figure below). This field causes current to flow in the conducting seawater. As the fish swims, it passes near objects that have resistivities different from that of seawater, which in turn causes the current to vary. Cells in the skin of the fish are sensitive to this changing current.

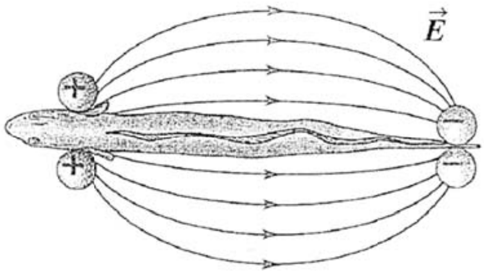


Figure 2. The electric field created around a Nile fish

We can model the seawater through which that electric field passes as a conducting tube of cross-sectional area 1.0 cm^2 and having a potential difference of 3.0 V across its ends. The length of a Nile fish is about 20 cm, and the resistivity of seawater is 0.13 Ω m.

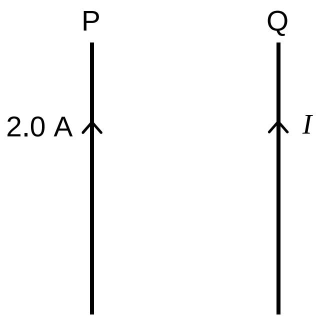
(i) Show that the resistance of the conducting tube of seawater is 260 Ω. [1]

(ii) Calculate the current through the tube of seawater. [1]

(iii) Suppose the fish swims next to a cylindrical object that is 10 cm long and 1.0 cm^2 in cross-sectional area and has half the resistivity of seawater. This object replaces the seawater for half the length of the original tube. Calculate the current through this new tube now. [3]

3 (a) Define magnetic flux density. [2]

(b) The figure below shows two long parallel wires P and Q placed 0.050 m apart.



Wire P carries a current of 2.0 A and wire Q carries a current I. Wire P experiences a force per unit length of 2.4 x 10^{-5} N m^{-1}.

(i) Explain why wire P experiences a magnetic force due to wire Q. [2]

(ii) Draw in the figure above, the force acting on wire P. [1]

(iii) Calculate the magnetic flux density acting at P due to current in Q. [2]

(iv) The magnetic flux density *B* due to a long straight wire carrying current I at distance *d* is given by

$$B = \frac{\mu_o I}{2\pi d} \quad \text{where } \mu_o = 4\pi \times 10^{-7} \text{ H m}^{-1}.$$

Show that the current I in wire Q is 3.0 A. [1]

4 A source of ultra-violet radiation illuminates a zinc plate and is placed beneath a piece of gauze as shown in Fig 4.1.
Photoelectrons are attracted to the gauze because of the potential difference between the plate and the gauze.
When *V* is varied, it is found that the photo current varies as shown in Fig 4.2.
When the intensity of light is I_1, graph A is obtained. When the intensity is increased to I_2, graph B is obtained.

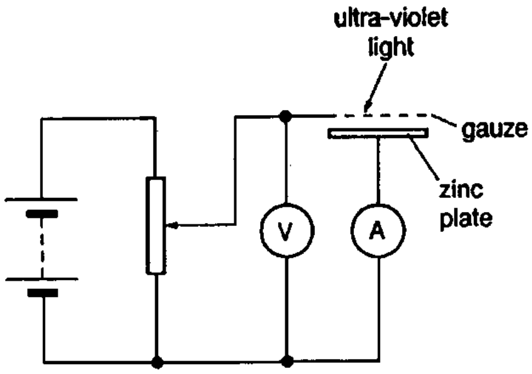


Fig 4.1

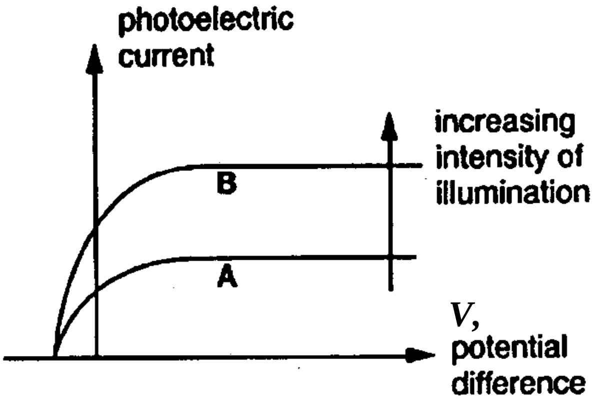


Fig 4.2

(a) Explain why curve A has a lower maximum value of photoelectric current than curve B. [2]

(b) The battery connections are now reversed such that the potential difference is made negative. Explain why the photocurrent diminishes to zero as the potential difference is made more negative. [2]

(c) Explain why the negative value of *V* where the photocurrent is zero remains the same for both curve A and curve B. [2]

(d) Given that the work function of the zinc plate is 4.3 eV and the wavelength of light used is 1.0×10^{-8} m, calculate the value of the negative potential difference that is required to reduce the photocurrent to zero. [2]

5 The graph in Fig. 5.1 shows how the acceleration of freefall *g* changes with distance from the centre of the Earth.

The distance from the centre of the Earth *x* is given in terms of the radius of the Earth. At the centre of the Earth the value of the acceleration is zero and the value increases to the value of 9.8 m s^{-2} at the Earth's surface. From the surface of the Earth the value decreases as shown.

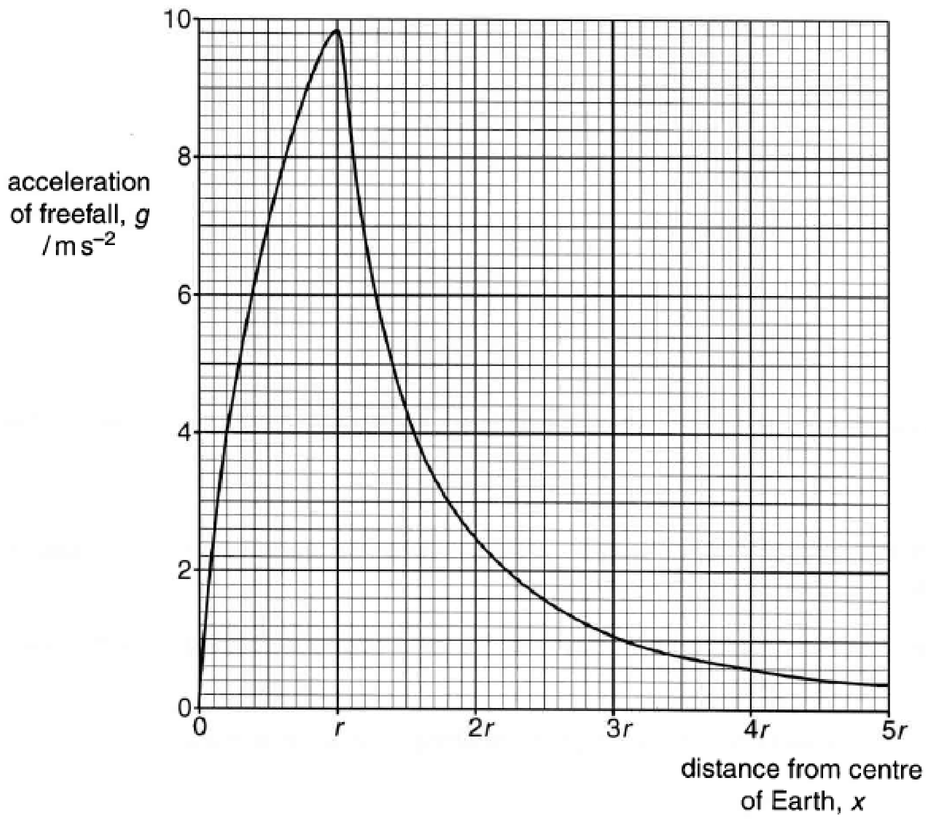


Figure 5.1

(a) Show, by taking readings from the graph, that g is inversely proportional to x^2, for distances beyond the Earth's surface. [3]

(b) The centre of the Moon is at a distance of 60r from the centre of the Earth. Deduce the value of g at this distance. [2]

(c) The International Space Station is at a height h above the Earth's surface. The value of g at this height is 8.81 m s^{-2}. Calculate h.

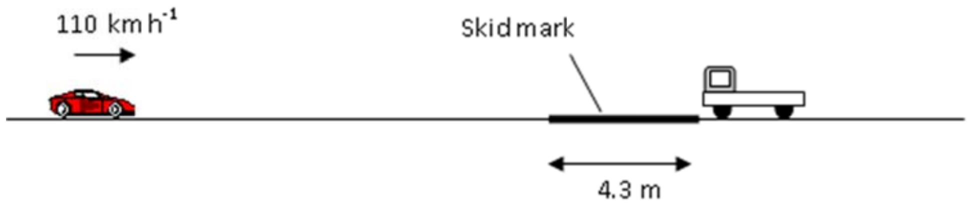
The radius of the Earth is 6370 km. [2]

(d) Explain how we can use Fig. 5.1 to determine the gain in gravitational potential energy of the International Space Station as it is launched from the Earth's surface into orbit. [1]

Section B

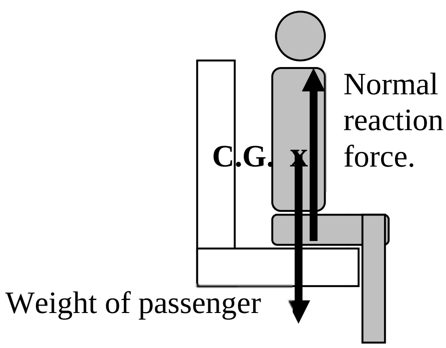
Answer **two** questions from this section.

6 A sports car was travelling along a straight road at a constant speed of 110 km h^{-1}. The driver suddenly applied the brakes because he saw a stationary lorry ahead. With the brakes applied, the front wheels of the car left skid marks on the road that are 4.3 m long, as illustrated in the figure below. It is estimated that, during the skid, the magnitude of the deceleration of the car is 0.85 *g*, where *g* is the acceleration of free fall.



(a) Determine the speed *v* of the car just before it collides with the stationary lorry. [2]

(b) The figure on the right shows the side view of a passenger of mass 65 kg in the front seat of the sports car. The normal reaction force and his weight acting on him at the instant when the brake is applied are shown.



(i) State Newton's *second* law of motion. [1]

(ii) Draw on the figure above, the direction of the frictional force acting on the passenger. [1]

(iii) With reference to all the forces acting on him, explain why the passenger will lean *forward* during this instant. [2]

(iv) Determine the net force acting on the passenger at this instant. [1]

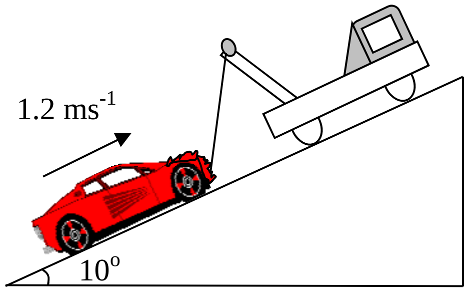
(c) The mass of the sports car was 1.2×10^3 kg and the collision with the stationary lorry of mass 2.2×10^3 kg was inelastic. They move off together as one body after the collision.

(i) Explain which physical quantity is not conserved in this collision. [2]

(ii) Determine the velocity of the sports car right after collision. State the assumption made in your calculation. [3]

(iii) The airbag in the sports car is deployed almost immediately after the collision. Explain how the airbag help to minimize the injuries to the front seat passenger. [2]

(d) After the accident, the sports car had to be towed by a 2.5×10^3 kg tow-truck up a slope at a constant speed of 1.2 m s^{-1} as shown in the figure on the right. The power *P* delivered by the tow-truck is 55 kW.

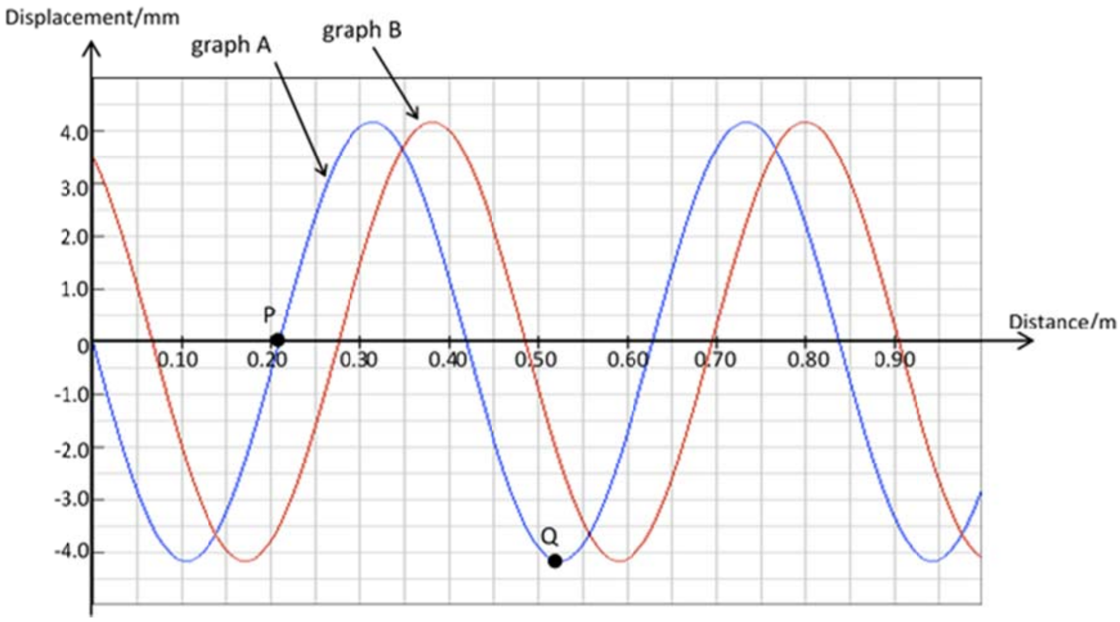


(i) By considering the sports car and the tow-truck as a whole system, calculate the rate of increase of the gravitational potential energy of the system. [2]

(ii) Determine the total resistive force, *R* acting on the whole system. [2]

(iii) Hence determine the driving force, *F* acting by the tow-truck. [2]

7 (a) Graph A shows the displacement at time t = 0 at different points on a longitudinal progressive sound wave that is travelling to the right. Positive displacement is taken to be to displaced to the right. Graph B shows the wave at t = 0.20 ms.



(i) Explain what is meant by longitudinal progressive wave. [2]

(ii) Mark on graph B
1. a point C where it is a region of compression (high pressure).
2. a point N where it is a region of normal pressure. [2]

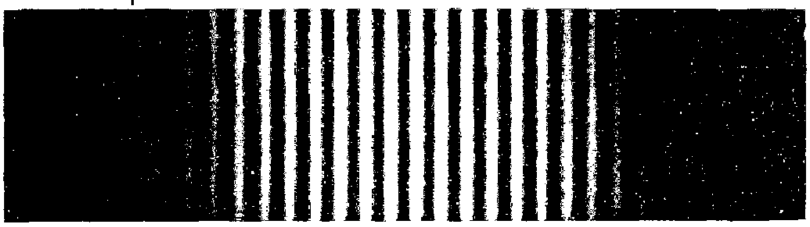
(iii) Use graphs A and B to determine, for the wave [6]
1. the wavelength

2. the wave speed

3. the frequency of the wave

4. the phase difference between points P and Q marked on graph A.

(b) The diagram below shows a full-scale photograph of an interference pattern produced when monochromatic light falls on a pair of slits 0.30 mm apart. The pattern was produced on a screen 1.5 m from the slits.



(i) State the principle of superposition and use this principle to explain why such an interference pattern is produced when light falls on a pair of closely spaced slit. [3]

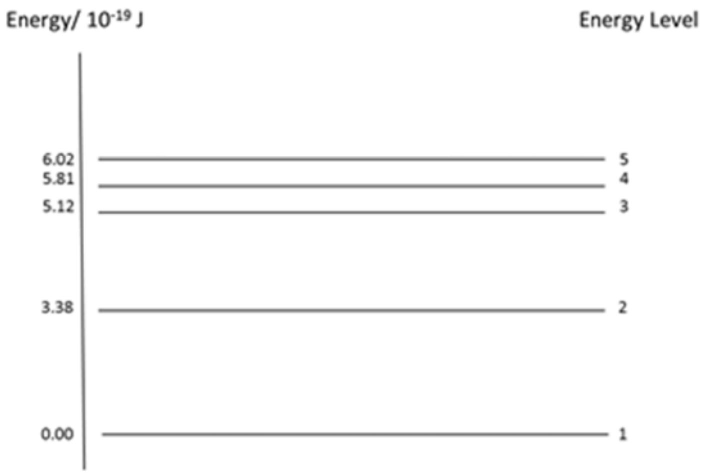
(ii) Use the photograph to obtain a value for the fringe spacing. Show your working clearly. [2]

(iii) Calculate the wavelength of the light used. [2]

(iv) Explain why the fringes near the centre of the photograph are brighter than those near the edges of the photograph. [2]

(v) Sketch the pattern which would be obtained on the screen if one of the slits were covered up. [1]

8 (a) The energy diagram shows the simplified representation of the 5 lowest energy levels of the outermost electrons in the sodium atom.



(i) By considering the transitions between these energy levels, state how many spectral emission lines might be produced by transitions among these levels. [1]

(ii) Electrons moving at a speed of 1.09×10^{6} m s^{-1} are now introduced into a sample of cool sodium vapour at ground state.

1. Calculate the possible frequencies of photons in the resulting emission spectrum. [3]

2. Calculate the lowest possible kinetic energy that the electrons will have after colliding with the sodium atoms. [2]

(iii) Now electromagnetic radiation of 5.50×10^{-19} J per photon is incident upon cool sodium vapour. Explain why no emission lines are observed. [1]

(iv) Energy level 2 is actually made up of two closely spaced sub levels (such that they appear as a single line on the diagram). Two bright yellow lines are visible in the emission spectra of sodium at 589.0 and 589.6 nm. Calculate the energy difference between these two sub levels and state the other energy level which is involved in the production of the two bright lines. [2]

(v) The ionization energy of sodium is 8.23 x 10^{-19} J.

1. Explain the meaning of ionization energy. [1]

2. Calculate the minimum wavelength of electromagnetic radiation that can be found in the sodium emission spectrum. State the type of radiation corresponding to this wavelength [2]

(b) A young astronomer proposes that the Sun contains sodium vapour in its atmosphere and designs an experiment to observe solar radiation. Incoming solar radiation is used to produce a solar spectrum. The light from the core of the Sun passes through the cooler gases surrounding the Sun, thus producing an emission spectrum that can be observed on Earth.

(i) Describe the difference in appearance between and absorption and emission spectrum. [2]

(ii) With the aid of a suitable diagram, explain how an absorption spectrum can be obtained, using equipment that can be found in a laboratory. [4]

(iii) Suggest how the young astronomer can prove his statement that the Sun contains sodium vapour in its atmosphere. [2]

End of paper