Centre Number	Index Number	Name	Class

RAFFLES JUNIOR COLLEGE

2009 Preliminary Examination

PHYSICS
Higher 1

8866 / 02

Paper 2

15 September 2009
2 hours

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

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index 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.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

You are advised to spend about one hour on each section.
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	
Section A	
1	
2	
3	
4	
5	
Section B	
6	
7	
8	
Total	

This booklet consists of **18** printed pages including the cover page.

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,	$p = \rho gh$
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 **(a)** State the conditions for a body to be in static equilibrium.

....

....

....

.... [2]

(b) A uniform rigid rod of weight W_1 = 400 N is attached to a vertical beam by a hinge as shown in Fig. 1. The other end of the rod is fastened to a support cable. The structure is used to support a load W_2 = 2000 N.

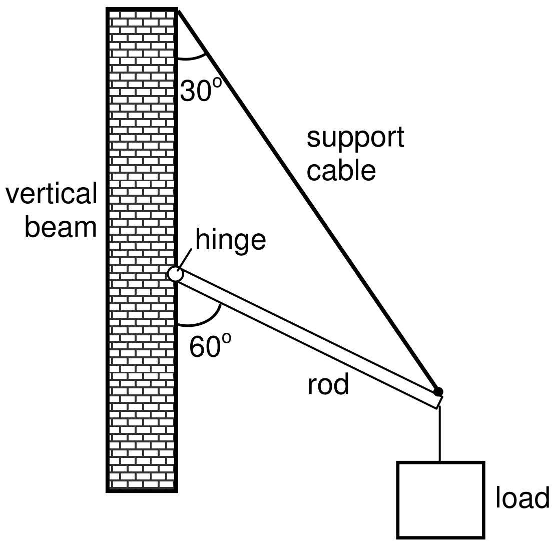

Fig. 1

(i) Show that the tension T in the support cable is 3810 N. [3]

(ii) Determine the magnitude and direction of the resultant force at the hinge.

Magnitude of resultant force = ... N

Direction of resultant force: .... [4]

(iii) The support cable can be lengthened or shortened to lower or lift the load respectively. State the change, if any, to the tension in the support cable when the crane is lifting the load.

....

.... [1]

2 **(a)** Define *magnetic flux density*.

....

....

.... [2]

(b) Fig. 2.1 shows two parallel straight wires placed at right angles to a ruler. The wires carry currents of $2I$ and I flowing in opposite direction.

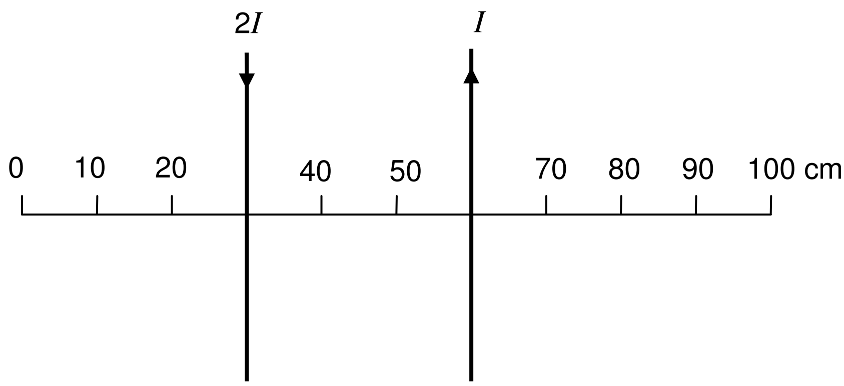

Fig. 2.1

Determine the point on the ruler at which the resultant magnetic field is zero.
You may assume that the Earth's magnetic field is negligible and that the magnetic flux density B at a distance r from a long, straight conductor is given by $B = \frac{\mu_o I}{2\pi r}$, where μ_o is the permeability of free space and I is the current in the conductor.

.... cm mark [2]

(c) Fig. 2.2 shows a metal wire **AB,** 12 m long, placed east–west on a wooden platform in a region where the horizontal component of the Earth's magnetic field (due north) has a magnitude of 1.8×10^{-5} T. The density and the resistivity of the wire is 1.0×10^{4} kg m^{-3} and 2.0×10^{-8} Ω m respectively.

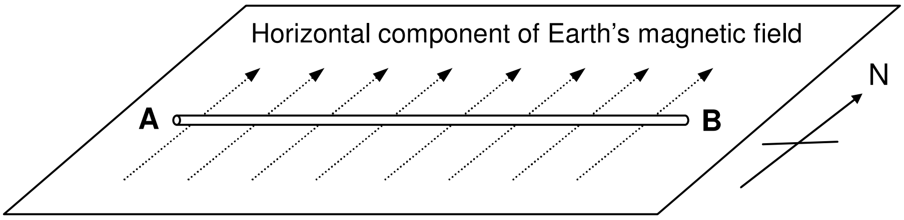

Fig. 2.2

A potential difference V is applied across the wire so that it just begins to rise from the platform.

(i) State which end of the wire (**A** or **B**) is at a higher potential.

.... [1]

(ii) Assuming that the electrical connections to the wire cause no appreciable restraint, determine the magnitude of V.

Magnitude of V = ... V [4]

3 **(a)** State the de Broglie relation for the momentum p of a particle in terms of its associated wavelength λ. [1]

(b) Calculate the wavelength of a particle of mass 1.82 x 10^{-28} kg when travelling with a speed equal to 10% of the speed of light.

wavelength = ... m [2]

4 (a) (i) Distinguish between the appearance of an emission line spectrum and an absorption line spectrum.

....

.... [1]

(ii) Describe how in practice an absorption line spectrum may be obtained.

....

....

....

.... [2]

(b) Fig. 4 is a simplified representation of the 5 lowest energy levels of the outermost electron in the sodium atom.

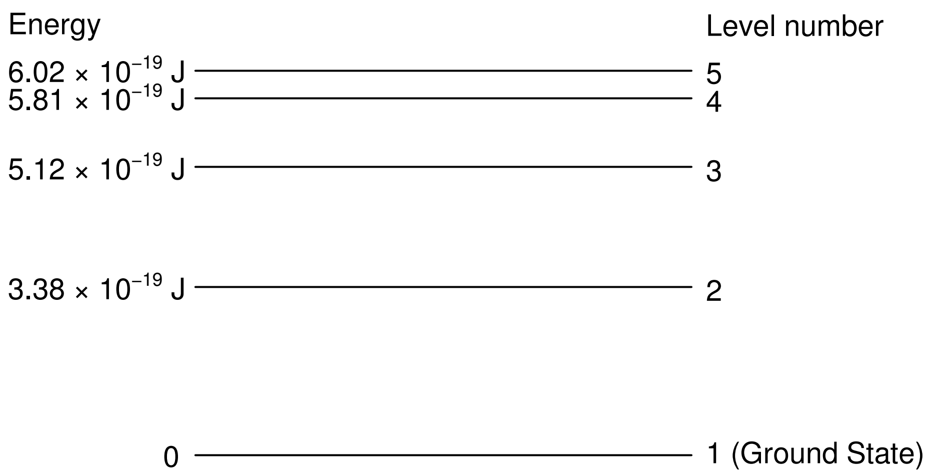

Fig. 4

Considering transitions between only these levels,

(i) state, in terms of level numbers, which spectral transition would lead to the emission of radiation of the shortest wavelength and calculate the wavelength of this radiation.

transition: ....

wavelength = ... m [2]

(ii) state the number of spectral emission lines that might be produced by transitions among these levels.

number of spectral lines: .... [1]

5 In a coal-fired power plant, burning coal is used to boil water and produce high-pressure steam, which then turns the turbines of an electric generator, thus producing electricity. Hydroelectric power plants use falling water to directly turn the turbines of the generators. Reservoirs hold water just behind dams while the turbines are usually located at the base of a dam (see Fig. 5).

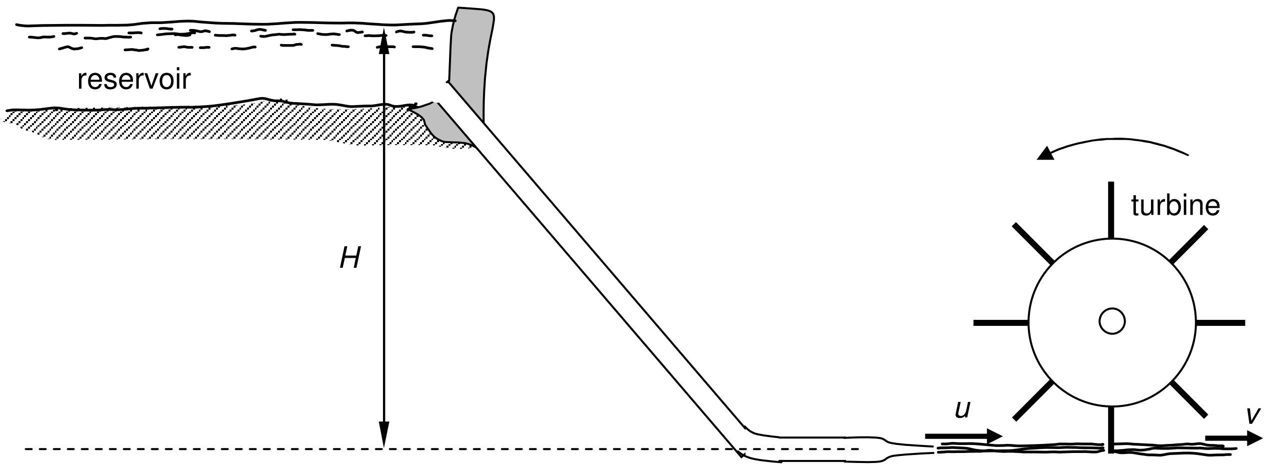

Fig. 5

The water emerges from a nozzle at the bottom of the dam with speed u and hits the blades of the turbine with this speed. After colliding with the blades of the turbine, the water moves in the same direction with speed v.

The table below shows the data for a given hydroelectric power plant.

Difference in height H between water level in the reservoir and turbine	220 m
Diameter d of the nozzle	0.060 m
Density ρ of water	1000 kg m^{-3}
Speed v of the water after hitting the blades of the turbine	10 m s^{-1}
Temperature of water	15^{o} C

(a) State the advantages of generating electricity in hydroelectric power plants over coal-fired power plants.

....

....

.... [2]

(b) **(i)** Assuming that the kinetic energy of the water leaving the nozzle is equal to the potential energy of the water at the surface of the reservoir, calculate the speed u of the water as it leaves the nozzle.

u = ... m s^{-1} [2]

(ii) Show that the mass of water flowing through the nozzle per unit time is 186 kg s^{-1}. [2]

(iii) Calculate the power carried by the water before hitting the blades of the turbine.

Power = ... W [2]

(iv) Assuming that the mass flow rate at the exit of the turbine is also 186 kg s^{-1}, calculate the maximum possible force the water could exert on the turbine blades.

Maximum force = ... N [2]

(v) Determine the maximum possible power imparted to the turbine.

Maximum power imparted to turbine = ... W [2]

Section B

Answer **two** questions from this section.

6 **(a)** A body has an initial velocity u and an acceleration a. After a time t, the body has moved a distance s and has a final velocity v. The motion is summarized by the following equations:

$$v = u + at \qquad \cdots(1)$$

$$s = \frac{1}{2}(u+v)t \qquad \cdots(2)$$

(i) State the assumption made about the acceleration a in the above equations.

.... [1]

(ii) With the aid of a v-t graph, derive equations (1) and (2). [3]

(b) A ball **A** of mass 2.5 kg is held stationary at the top of a plane which is inclined at 15° to a horizontal surface. The ball is released and it rolls down the plane. It then collides head-on with a stationary ball **B** of mass 4.0 kg on the horizontal surface as shown in Fig. 6.1. Assume that all frictional forces are negligible.

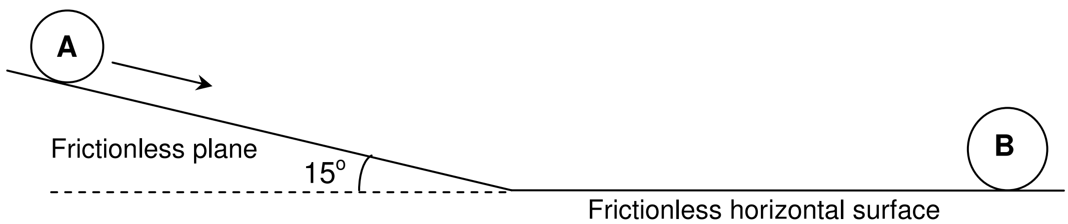

Fig. 6.1

(i) On Fig. 6.1, draw and label all the forces acting on ball **A**. [1]

(ii) Calculate the acceleration of ball **A** along the inclined plane.

Acceleration of ball **A** = ... m s^{-2} [2]

(iii) The velocity of ball **A** just before impact with ball **B** is 3.0 m s^{-1}. Calculate the distance ball **A** has travelled down the slope.

Distance down the slope = ... m [2]

(iv) Assuming that ball **A** collides *elastically* with ball **B**, calculate the speed of each ball after the collision.

Speed of ball **A** = ... m s^{-1}

Speed of ball **B** = ... m s^{-1} [4]

(v) Supposing the two balls stick together after the collision. Determine

1. the common speed of the balls after the collision.

Common speed = ... m s^{-1} [2]

2. the loss in the total kinetic energy of the balls in the collision.

Loss in total kinetic energy = ... J [2]

(c) A mass of 0.30 kg slides from rest at height 2.0 m down a smooth curved surface which becomes horizontal at zero height. A spring is fixed horizontally on the level part of the surface as shown in Fig. 6.2. When the mass encounters the spring, it compresses it by 20 cm. Determine the force constant of the spring.

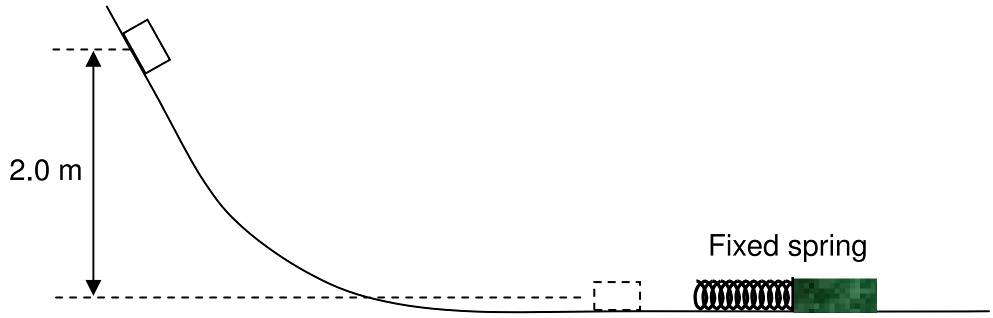

Fig. 6.2

force constant = ... N m^{-1} [3]

7 **(a)** **(i)** Define *resistance*.

....

.... [1]

(ii) Write down an equation which relates *resistance* and *resistivity*. Identify all the symbols in the equation. [2]

(b) Fig. 7.1 shows a section of a long tungsten wire of radius 0.20 mm that has a uniform copper jacket of outside radius 0.40 mm. The resistivity of tungsten is 5.25×10^{-8} Ω m and the resistivity of copper is 1.70×10^{-11} Ω m.

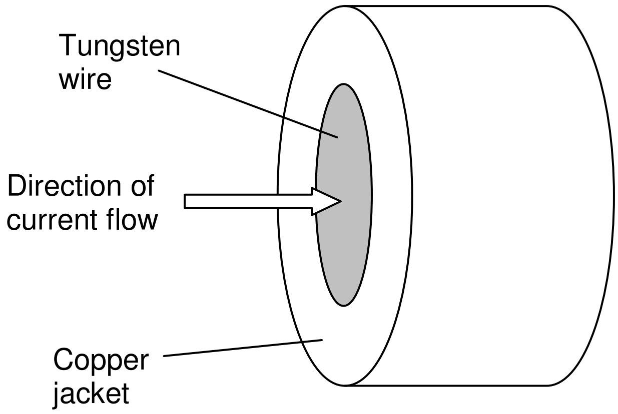

Fig. 7.1

When a current is made to flow through the *whole* cross-section of the tungsten wire and the copper jacket, what is the ratio of current through tungsten to that through copper?

ratio = ... [4]

(c) Initially, with the switch open, the voltmeter in the circuit of Fig 7.2 below reads 12.0 V. The switch is then closed and the voltmeter reading changes to 11.4 V.

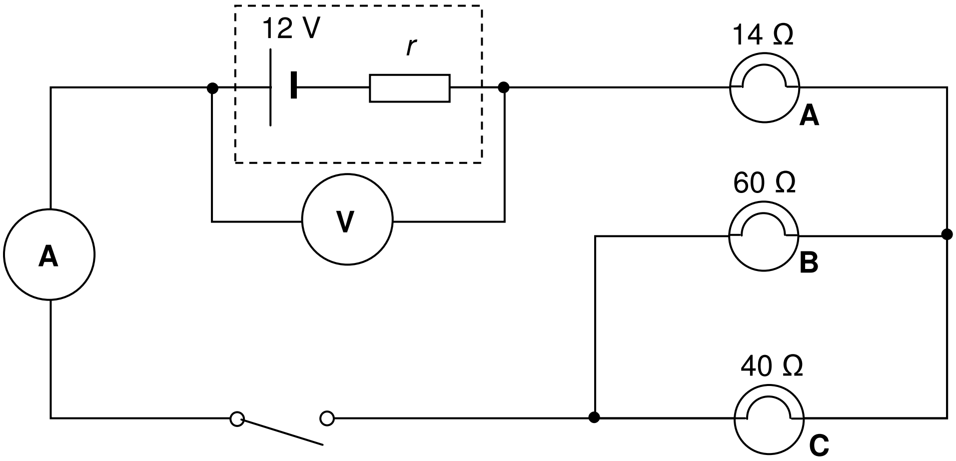

Fig. 7.2

(i) Explain why the voltmeter reading changes when the switch is closed.

....

....

....

.... [2]

(ii) Calculate the current flowing through the ammeter.

current = ... A [3]

(iii) Hence, calculate the internal resistance of the battery.

Internal resistance = ... Ω [2]

(iv) Calculate the power supplied by the 12 V battery and the power delivered to **each** light bulb.

Power supplied by 12 V battery = ... W

Power delivered to light bulb **A** = ... W

Power delivered to light bulb **B** = ... W

Power delivered to light bulb **C** = ... W [4]

(v) State and explain, without any further calculations, what happens to the brightness of light bulb **C** when light bulb **B** is removed from the circuit.

....

....

....

.... [2]

8 (a) (i) Distinguish between *longitudinal* and *transverse* waves.

....

....

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....

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....

....

.... [3]

(ii) Light of intensity 1.0×10^{-10} W m^{-2} falls normally upon a silver surface that has one free electron per atom. The atoms are 2.6×10^{-10} m apart and each electron in the silver requires a minimum energy of 7.5×10^{-19} J before it can be emitted from the silver surface.

Treat the light as waves and assume that the light energy is uniformly distributed over the surface and all the light is absorbed by the surface electrons.

1. Calculate the energy gained per second by each free electron.

energy gained per second = ... J s^{-1} [2]

2. Determine the time required for an electron to collect sufficient energy to be freed as a photoelectron.

time = ... s [2]

3. Comment on your answer to part **(a)(ii)2** with reference to experimental observations of the photoelectric effect.

....

....

....

.... [2]

(b) Briefly explain how an interference pattern may be obtained when waves from two sources meet.

....

....

....

....

....

.... [4]

(c) Fig. 8 shows the set-up for a Young's double-slit experiment. Coherent light of wavelength 500 nm falls on the slits. The two slits are 0.500 mm apart and a viewing screen is placed 1.20 m from the slits. An interference pattern is formed on the screen.

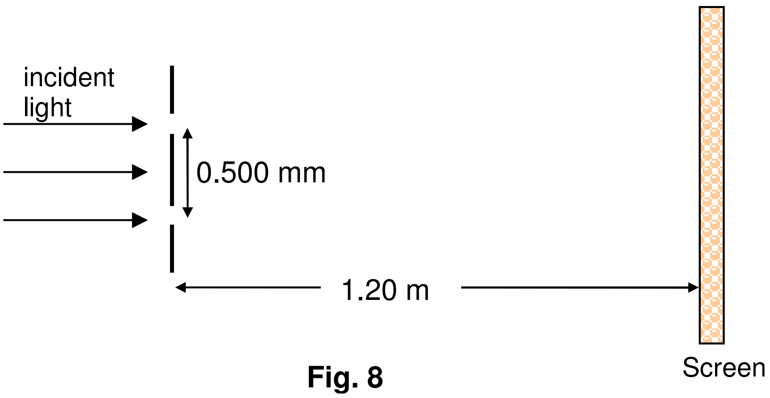

Fig. 8

(i) Calculate how far apart the bright interference fringes would be on the screen.

Fringe separation = ... m [2]

(ii) Describe the effect, if any, on the interference pattern if each of the following changes were made independently.

1. The incident light is replaced by light of wavelength 700 nm.

....

....

....

2. The slits are moved farther apart.

....

....

....

3. The intensity of light entering one of the slits is reduced.

....

....

.... [5]

************ **END OF PAPER** ************