# JURONG JUNIOR COLLEGE
## 2015 JC2 Preliminary Examination

| Name | | Class | 15S |
|---|---|---|---|

**PHYSICS** **8866/02**
**Higher 1**
**02 September 2015**
Paper 2 Structured Questions
**2 hours**

Candidates answer on the Question Paper
No Additional Materials are required

**READ THESE INSTRUCTIONS FIRST**

Do not open this booklet until you are told to do so.

Write your **name** and **class** in the spaces provided at the top of this page.

There are **eight** questions in this paper.
Answer **all** the questions in **Section A**
Answer **two** of the questions in **Section B**.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.
Do not use highlighters, glue or correction fluid.

The number of marks is given in brackets [ ] at the end of each question or part question.

**Total marks: 80**

| For Examiner's Use | |
|---|---|
| 1 | / 6 |
| 2 | / 7 |
| 3 | / 10 |
| 4 | / 7 |
| 5 | / 10 |
| 6 | / 20 |
| 7 | / 20 |
| 8 | / 20 |
| **Total** | **/ 80** |

**(This question paper consists of 21 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, | $p$ | $= \rho gh$ |
| 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 zoologist studying the wildlife in Africa decided to model the thigh bone of a male African Elephant as a physical pendulum pivoted at the hip joint of the elephant.

The period of the physical pendulum can be expressed as

$$T=2\pi\sqrt{\frac{I}{mgh}}$$

where $T$ is the period of oscillation,

$I$ is the rotational inertia of the pendulum about the pivot which has a unit of kg $m^2$,

$m$ is the mass of the thigh bone,

$g$ is the acceleration of free fall and

$h$ is the distance of the centre of gravity of the bone from the pivot.

**(a)** Show that the equation is homogeneous in terms of base units.

[2]

**(b)** If the value of $I$ is (0.2085 ± 0.0001) in kg $m^2$, and $m$ and $h$ are measured to be (4.1 ± 0.5) kg and (47.0 ± 0.1) cm respectively, calculate $T$ and express it with its associated uncertainty.

$T$ = ( ............ ± ............ ) s [4]

**2** **(a)** Define *acceleration*.

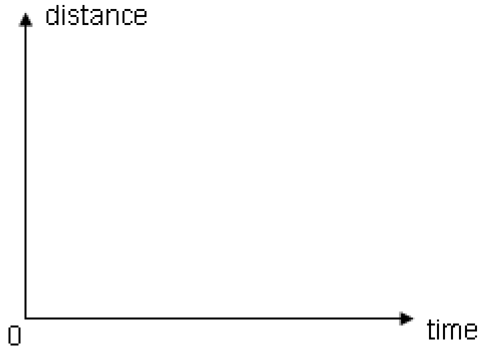
[1]

**(b)** A train driver Anthony spots another train, its tail 100 m ahead of him on the same track. Anthony's train is moving at a speed of 72 km $h^{-1}$ and the other train is moving at a constant speed of 54 km $h^{-1}$ in the same direction.

**(i)** State the maximum speed of Anthony's train, in m $s^{-1}$, in order to avoid a collision at the time his train has closed the gap of 100 m between the two trains.

speed of Anthony's train = .................... m $s^{-1}$ [2]

**(ii)** Sketch the distance-time graph of Anthony's train.




[1]

**(iii)** Determine the minimum deceleration Anthony's train must have in order to just avoid a collision.

minimum deceleration = .................... m $s^{-2}$ [3]

**3** In a photoelectric effect experiment, the maximum kinetic energy $E_{k,max}$ of the ejected photoelectrons is measured for various wavelengths, $\lambda$ of the incident light.

Fig. 3.1 shows the variation with wavelength $\lambda$ of the incident light, of $E_{k,max}$.

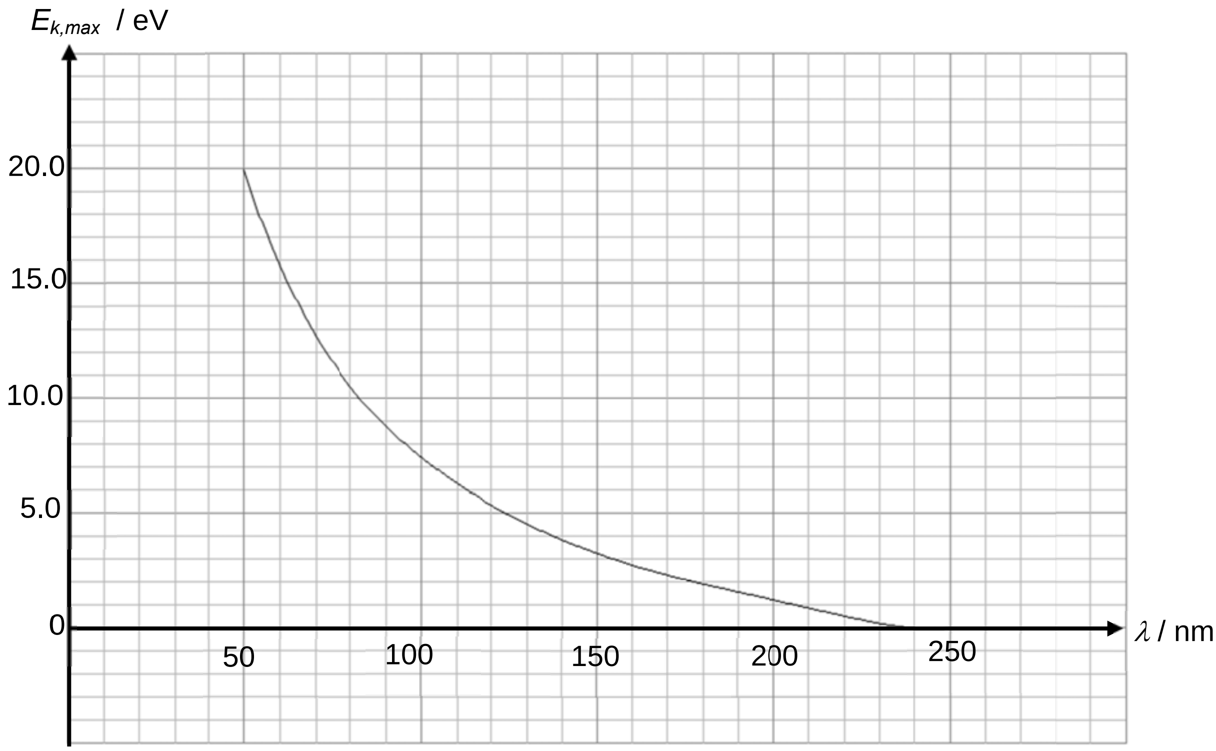



**Fig. 3.1**

**(a)** **(i)** From Fig. 3.1, state and explain one piece of evidence that supports the theory that light has a particulate nature.

[2]

**(ii)** Describe briefly how the maximum kinetic energy of the emitted electrons may be measured experimentally.

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**(b)** Using a suitable point from Fig 3.1, determine the work function of the metal used.

work function = .............................. eV [3]

**(c)** Data from experiments like this are often plotted showing the variation with $1/\lambda$ of $E_{k,max}$, instead of that in Fig. 3.1.

In Fig. 3.2, sketch a graph to show the variation with $1/\lambda$ of $E_{k,max}$.

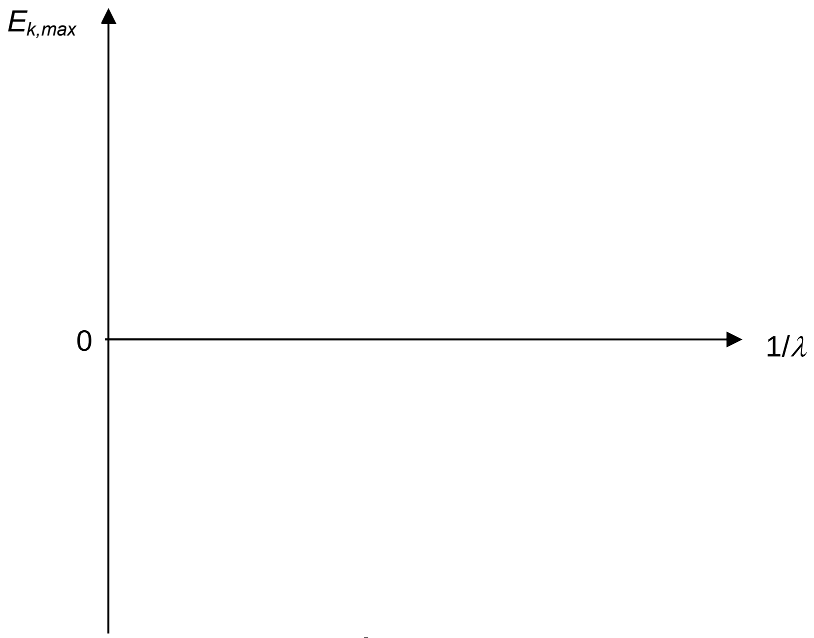


**Fig. 3.2**

[2]

**4** **(a)** By using the equations of motion, show that the kinetic energy $E_k$ of an object of mass $m$ travelling with speed $v$ is given by

$$E_k = \frac{1}{2}mv^2$$

[3]

**(b)** Fig. 4.1 shows two blocks A and B connected by a light inextensible cord passing over a frictionless pulley. When both blocks are released, block A starts to move from rest along a rough plane which is inclined at 30° to the horizontal. The speed of block B just before hitting the ground is 4.0 m $s^{-1}$

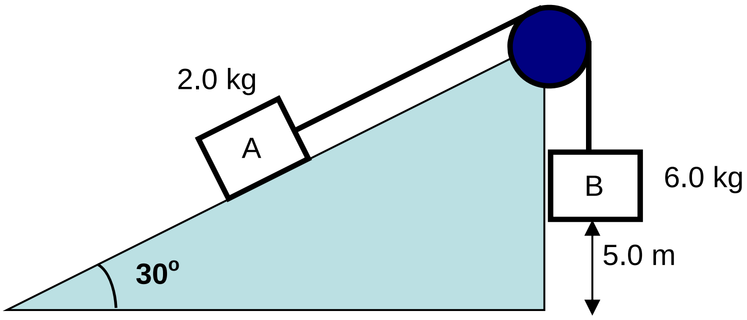


**Fig. 4.1**

Calculate the average friction force acting on block A.

frictional force = ........................ N [4]

**5** **(a)** Write down the equation that defines magnetic flux density in terms of the force on a current carrying conductor. State the meaning of each term used.

[3]

**(b)** Fig 5.1 shows two-current carrying conductor X and Y.

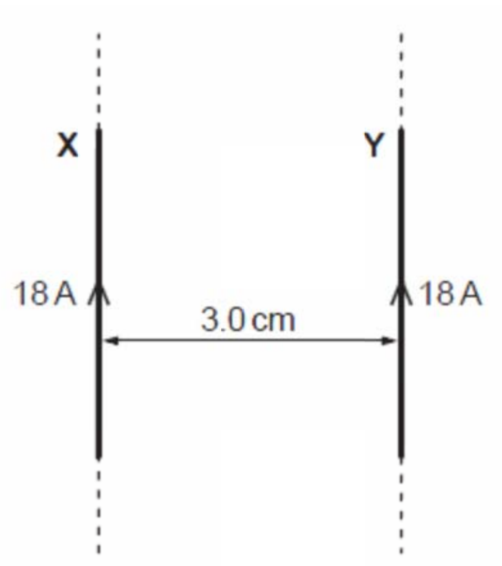


**Fig 5.1**

The current in each wire is 18 A. The wires are parallel to each other and are 3.0 cm away from each other.

**(i)** State the direction of the magnetic field at Y due to the current in wire X.

[1]

**(ii)** Draw an arrow on Fig 5.1 to show the direction of the magnetic force experienced by wire Y. Label this force F. [1]

**(iii)** Fig 5.2 shows how the magnetic flux density *B*, due to the current carrying wire X varies with distance *r* from the centre of the wire.

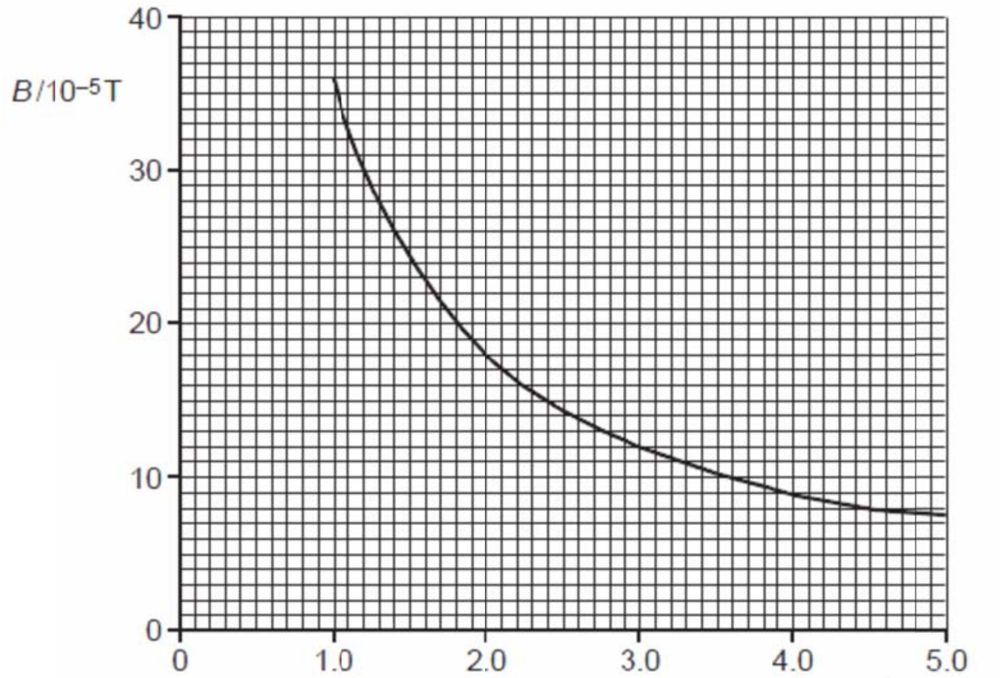


**Fig 5.2**

Using information provided from Fig 5.2,

**1.** show that the magnetic flux density *B* is inversely proportional to the distance *r* from the centre of the wire,

[3]

**2.** determine the force acting on a 0.25 m length of the wire Y when the wires are 3.0 cm apart.

force = ____________________ N [2]

**Section B**

Answer **two** of the questions in this section.

**6** **(a)** Define *resistance*.

[1]

**(b)** A 12 V source with negligible internal resistance is connected in parallel, as shown in Fig. 6.1, to three lamps rated 12 V but with different power ratings. The filament of a lamp operated at twice its rated voltage will spoil immediately.

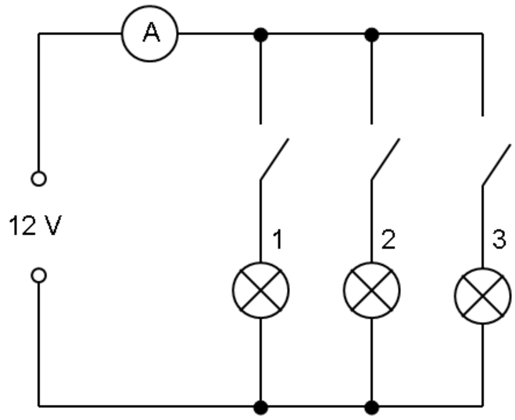


**Fig. 6.1**

When only lamp 1 is switched on, the ammeter reads 0.10 A.

When lamps 1 and 2 are switched on, the ammeter reads 0.30 A.

The ammeter reads 0.60 A when all the three lamps are switched on.

Calculate

**(i)** the power of the second lamp,

power = ............................ W [2]

**(ii)** the effective resistance of the circuit.

resistance = ................................ Ω [2]

**(iii)** Given that the filaments in all the three lamps are made of the same material and are of the same length,

**1.** identify the lamp with the thinnest filament,

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

**2.** identify the lamp which will be the hottest when in use.

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

**(iv)** A student connected the three lamps in series to a 36 V source. He argues that since each lamp is designed to work with 12 V applied across it, none of the bulbs in series will spoil with 36 V applied across them.

Explain, with detailed working, whether the student is correct or wrong, assuming that the resistance of each lamp remains constant.

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**(c)** **(i)** Define *electromotive force* of a source.

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**(ii)** Distinguish between *electromotive force* and *potential difference*.

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**(d)** Fig. 6.2 shows a circuit consisting of two resistors connected in series to a d.c. supply.

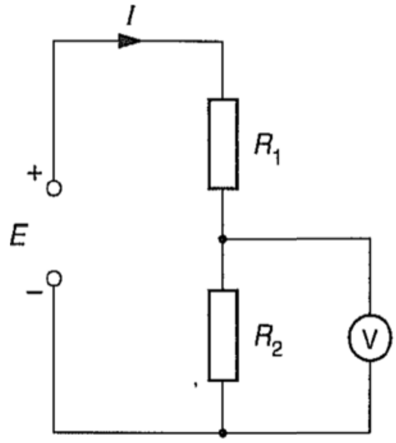


**Fig. 6.2**

The resistors have resistances $R_1$ and $R_2$. The supply has e.m.f. $E$ and negligible internal resistance. The current from the supply is $I$. The voltmeter has an infinite resistance.

**(i)** Show that the voltmeter reading $V$ is given by the relation

$$V = \left(\frac{R_2}{R_1 + R_2}\right)E.$$

[3]

**(ii)** Fig. 6.3 shows a circuit that includes a thermistor.

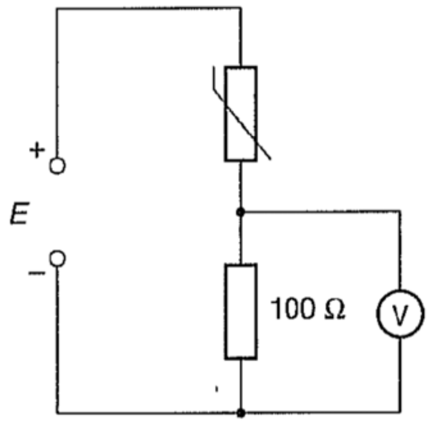


**Fig. 6.3**

Describe and explain how the voltmeter reading changes as the temperature of the thermistor is increased.

[3]

**7** **(a)** Two coherent sources A and B, which are in phase with each other, emit wave of wavelength 40.0 mm.

The amplitude of the wave from source B is twice that of source A.

A detector is placed at the point P where it is 1.00 m from A and 1.18 m from B as shown in Fig. 7.1. (Not drawn to scale)

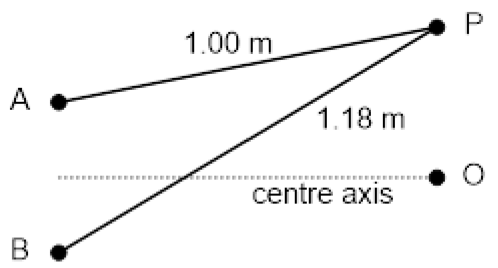


**Fig. 7.1**

**(i)** State the type of electromagnetic radiation that is emitted by sources A and B.

radiation is .................................................. [1]

**(ii)** Suggest a suitable distance between sources A and B.

distance = .................................... m [1]

**(iii)** Explain why the intensity detected at P is a minimum.

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.......................................................................................................................... [3]

**(iv)** Determine the ratio of the intensity at P to the intensity at O.

ratio = .......................................... [2]

**(v)** State the type of interference at P when source B is changed to be 180° out-of-phase with source A.

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

**(b)** A vibrating dipper causes a water wave of small amplitude to travel in a tank of water $d$ = 2.6 cm deep, as shown in Fig. 7.2.

The mean speed $v$ of the travelling water wave in shallow water is dependent on both $d$ and the acceleration of freefall $g$ and is given by $v = \sqrt{gd}$ .

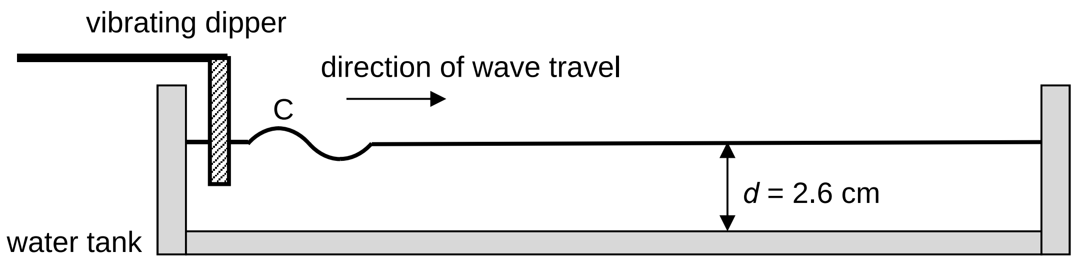


**Fig. 7.2**

**(i)** Calculate the frequency of the vibrating dipper, given that the distance between 2 adjacent crests of the water wave is 0.025 m.

frequency = .......................................... Hz [2]

**(ii)** Deduce the time taken for crest C to travel a distance of 125 mm.

time taken = .................................... s [2]

**(c)** Explain, using diagrams, what is meant by the following terms when applied to wave motion.

**(i)** coherent

[2]

**(ii)** polarisation

[2]

**(d)** Discuss how, using a calibrated cathode-ray oscilloscope (c.r.o.), you could determine the **frequency** of a note played by a trumpet, using stationary waves. You should draw a diagram to help your answer.

[4]

**8.** **(a)** State Newton's second and third laws of motion.

Newton’s second law:

Newton’s third law:

[4]

**(b)** Define *force.*

[1]

**(c)** Using sketches, with labelled arrows showing the directions of velocity and acceleration, describe situations in which an object

**(i)** has an acceleration at right angles to its velocity,

**(ii)** has an acceleration in the opposite direction to its velocity.

Add to your sketches a labelled arrow showing the direction of the resultant force acting on the object in each case.

[4]

**(d)** **(i)** State the principle of conservation of momentum.

[1]

**(ii)** Does the principle apply in cases where two colliding objects lose kinetic energy as a result of sticking to one another at the point of collision? Explain your answer with reference to Newton's third law.

[2]

**(e)** A particle of mass 1.20 kg collides head -on and elastically, with a ball of mass 0.60 kg moving with a speed 0.2 m $s^{-1}$ in opposite direction. The ball moves off with a speed of 0.1 m $s^{-1}$. Calculate for the particle

**(i)** its initial speed,

initial speed = ______________ m $s^{-1}$ [4]

**(ii)** its final speed.

final speed = ________________ m $s^{-1}$ [2]

**(f)** Suggest, with a reason, if the equations used in (e) would apply if the collision took place on a rough surface.

[2]

**End of Paper**