H

NATIONAL JUNIOR COLLEGE

SENIOR HIGH 2 PRELIMINARY EXAMINATIONS

Higher 1

CANDIDATE NAME

SUBJECT CLASS | REGISTRATION NUMBER

PHYSICS **8866/01**

Paper 1 Multiple Choice **2017**

Additional Materials: Multiple Choice Answer Sheet **1 hour**

READ THE INSTRUCTION FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

This document consists of 10 printed pages.

Data

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

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,	$1/R = 1/R_1 + 1/R_2 + \ldots$

1 Which of the following shows the base units of magnetic flux density?

A T **B** kg s^{-2} A^{-1} **C** kg m^{-1} s^{-1} **D** Wb m^{-2}

2 An astronaut stands by the rim of a crater on the moon, where the acceleration of gravity is 1.62 m s^{-2}. To determine the depth of the crater, she drops a rock and measure the time it takes for it to hit the bottom. If the time is 6.3 s, what is the depth of the crater?

A 10 m **B** 14 m **C** 26 m **D** 32 m

3 A projectile is launched at 45° to the horizontal with initial kinetic energy E.
Assuming air resistance to be negligible, what will be the kinetic energy of the projectile when it reaches its highest point?

A 0.50 E **B** 0.71 E **C** 0.87 E **D** E

4 A boy kicks a football from ground level with a certain initial velocity at an angle 30.0° above the horizontal. In 2.00 s the ball completes its trajectory and hits the ground. What is the initial velocity of the ball?

A 4.90 m s^{-1} **B** 9.80 m s^{-1} **C** 19.6 m s^{-1} **D** 39.2 m s^{-1}

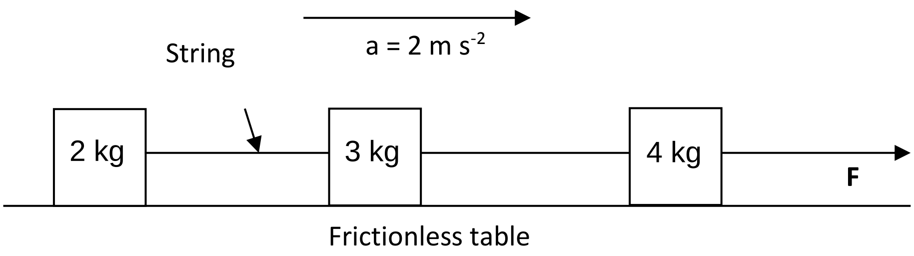
5 A passenger on a bus moving forward at constant speed notices that a ball which has been at rest in the aisle suddenly starts to roll towards the front of the bus. What can be concluded about the motion of the bus from this observation?

A The bus is moving at constant speed.
B The bus is decelerating.
C The bus is accelerating.
D The bus is making a turn.

6 A stream of water from a pipe travels horizontally at 10 m s^{-1}. The stream strikes a wall and splashes back horizontally at 5 m s^{-1}. What is the pressure exerted by the wall on the water? (density of water = 1000 kg m^{-3})

A 50 kPa **B** 100 kPa **C** 150 kPa **D** 200 kPa

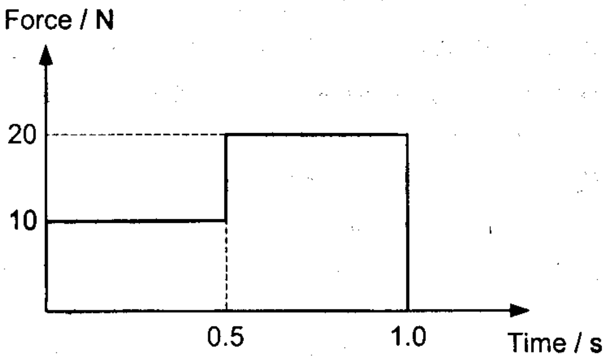
7 Three blocks of masses 2 kg, 3 kg and 4 kg are connected by an inextensible string on a horizontal frictionless table as shown. The blocks are pulled to the right with an acceleration of 2 m s^{-2} by an applied force *F*.



What is the tension in the string which connects the 3 kg mass to the 4 kg mass?

A 4 N **B** 6 N **C** 10 N **D** 14 N

8 A 2.0 kg object is initially moving at a speed of 5.0 m s^{-1} *on a frictionless horizontal* surface. A force as indicated in the graph is applied on the object in the direction of travel.



After one second, the speed of the object is

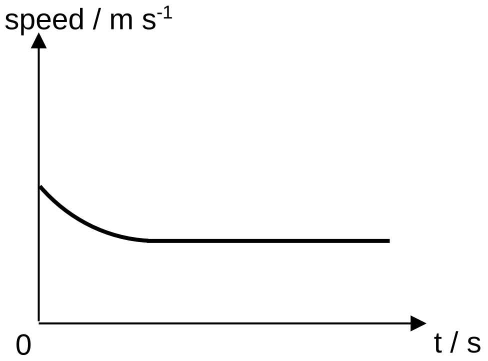
A 7.5 m s^{-1} **B** 10 m s^{-1} **C** 12.5 m s^{-1} **D** 15 m s^{-1}

9 A mass of 2 kg travelling at 3 m s^{-1} undergoes elastic collision with a group of four 1 kg masses that are at rest in contact with each other. The four masses are lined up in the same direction as the velocity of the 2 kg mass. As a result of the collision

A the 2 kg mass comes to a stop and one of the 1 kg masses takes off at 6 m s^{-1}.
B the 2 kg mass comes to a stop and two of the 1 kg masses takes off at 3 m s^{-1}.
C the 2 kg mass comes to a stop and three of the 1 kg masses takes off at 2 m s^{-1}.
D the 2 kg mass and the four other masses travel at 1 m s^{-1}.

10 A ball is dropped from a great height into the sea and enters the sea at high speed. The density of the ball is less than the density of sea water. If viscous force cannot be ignored, which of the following is the speed-time graph of the ball after it enters the sea?

A



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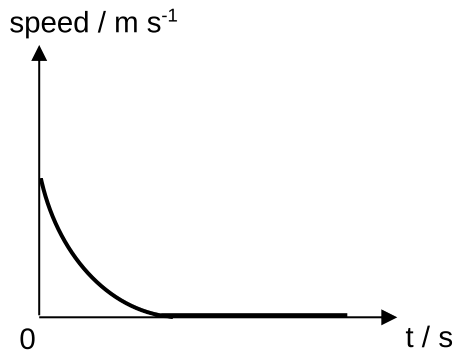
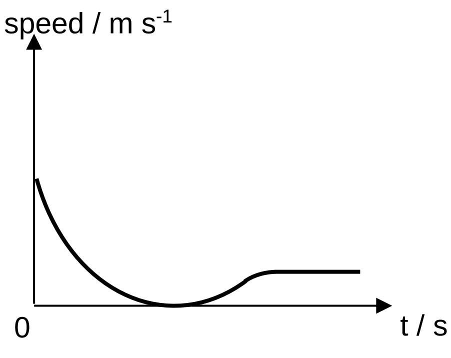
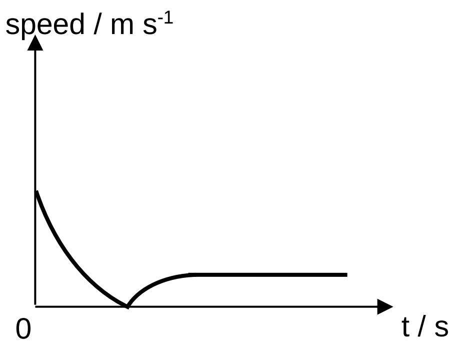


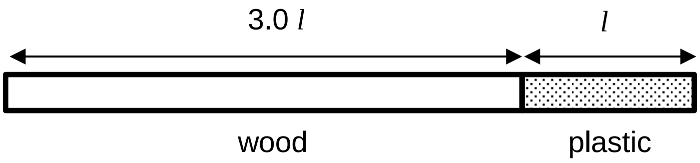
C



D



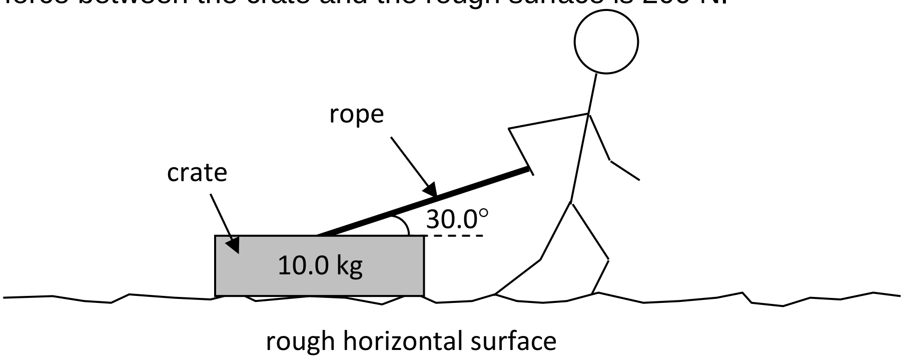
11 A rod consists of a uniform wood section and a uniform plastic section, as shown.



The length of the wooden section is 3.0 *l* and the length of the plastic section is *l*. The density of the wooden section is 600 kg m^{-3} and the density of the plastic section is 1000 kg m^{-3}. What is the distance of the centre of gravity of the entire rod from its left end?

A 1.1 *l* **B** 1.8 *l* **C** 2.2 *l* **D** 2.9 *l*

12 A man drags a crate of mass 10.0 kg across a rough horizontal surface at a constant speed of 0.800 m s^{-1}. The rope makes an angle of 30.0 ° with the horizontal. The average frictional force between the crate and the rough surface is 200 N.



What is the instantaneous power input by the man on the crate 2.00 seconds after he starts to accelerate the crate uniformly at 1.00 m s^{-2}? The angle which the rope makes with the crate remains unchanged.

A 0 W **B** 194 W **C** 588 W **D** 679 W

13 A block of mass *m* is pushed against a spring of spring constant *k*. The spring is compressed by a distance *d*, the block is then released. It is launched by the spring along a horizontal frictionless surface with a final speed *v*. A second block, this one having mass 4*m* is pushed against the same spring by distance 6*d* and released. What is the final speed of the block in this case?

A *v* **B** 2*v* **C** 3*v* **D** 4*v*

14 Which statement describes a situation when polarisation could not occur?

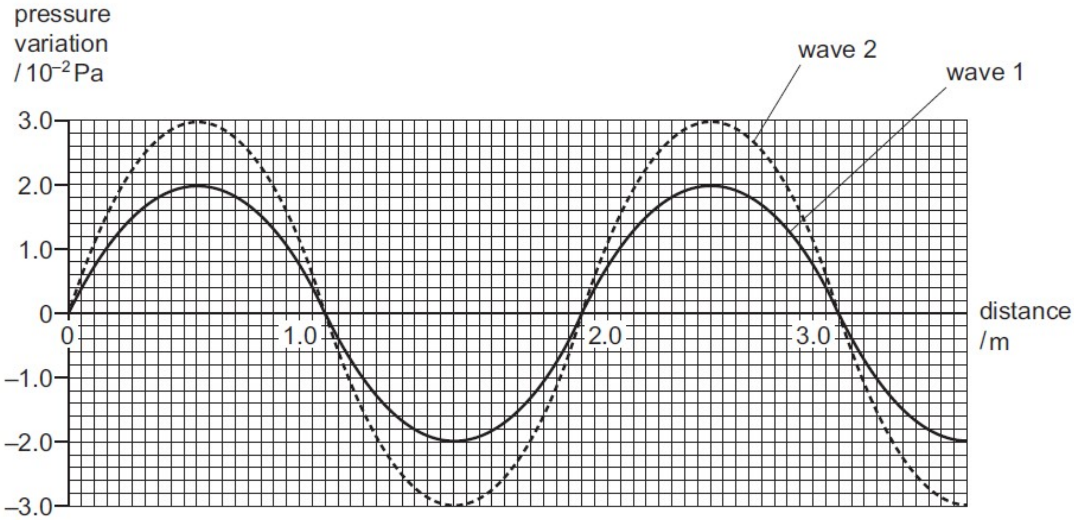
A Light waves are reflected.
B Light waves are scattered.
C Microwaves pass through a metal grid.
D Sound waves pass through a metal grid.

15 A vertical aerial (vertical transmission axis) can detect EM waves of intensity I_o from signals from a source. However, during a thunderstorm, the aerial was bent in a particular angle θ and the intensity detected now is $\frac{3}{4}I_O$. What is the angle θ ?

A 15° **B** 30° **C** 45° **D** 60°

16 A sound wave consists of a series of moving pressure variations from the normal, constant air pressure.

The graph shows these pressure variations for two waves at one instant in time.



Wave 1 has an intensity of 1.6×10^{-6} W m^{-2}.

What is the intensity of wave 2?

A 2.4×10^{-6} W m^{-2} **B** 3.0×10^{-6} W m^{-2} **C** 3.6×10^{-6} W m^{-2} **D** 4.5×10^{-6} W m^{-2}

17 A tube with one end open and the other end closed, has a harmonic of frequency of 448 Hz and the next higher harmonic has a frequency of 576 Hz. What is the length of the tube? (Take the speed of sound in air as 343 m s^{-1}.)

A 1.34 m **B** 0.670 m **C** 0.335 m **D** 1.00 m

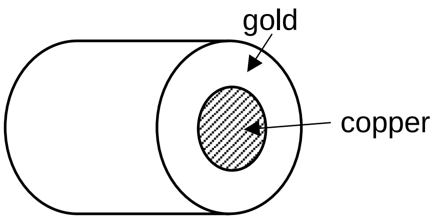
18 In a Young's double-slit experiment, the separation between the first and third dark fringe is 3.5 mm when the wavelength used is 6.6×10^{-7} m. The distance from the slits to the screen is 0.80 m. The separation of the two slits is

A 0.15 mm **B** 0.25 mm **C** 0.30 mm **D** 0.45 mm

19 Which one of the following is a correct statement for a number of resistors connected in series or parallel?

A The total resistance in a series circuit decreases as more resistors are added.
B The flow of current is different through resistors connected in a series circuit.
C The voltage is different across resistors connected in a parallel circuit.
D The total resistance in a parallel circuit decreases as more resistors are added.

20 A composite wire of diameter 4.0 mm consists of a copper core of diameter 2.0 mm surrounded by layer of gold as shown in the figure.



The resistivity of copper is $1.7 \times 10^{-8}\ \Omega$ m and the resistivity of gold is $2.4 \times 10^{-8}\ \Omega$ m.
What is the resistance of 1.0 m of the composite wire?

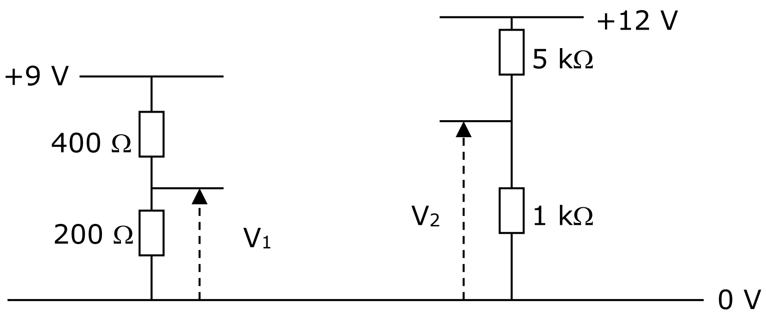
A $4.3 \times 10^{-4}\ \Omega$ **B** $1.7 \times 10^{-3}\ \Omega$ **C** $3.2 \times 10^{-3}\ \Omega$ **D** $8.0 \times 10^{-3}\ \Omega$

21 The drift velocity of the electrons through a cylindrical metal conductor is *v* when the current flowing through the conductor is *I*.

What is the new drift velocity of the electrons if the diameter of the cylindrical conductor is doubled and the current flowing through is also doubled?

A v/2 **B** v **C** **2**v **D** **4**v

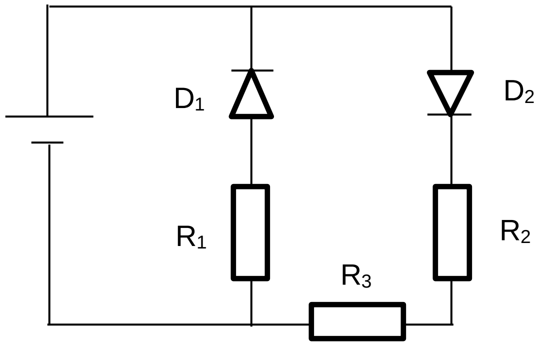
22



In the above circuit, which one of the following is equal to (V2 – V1) in volts?

A - 4 **B** - 1 **C** 4 **D** 7

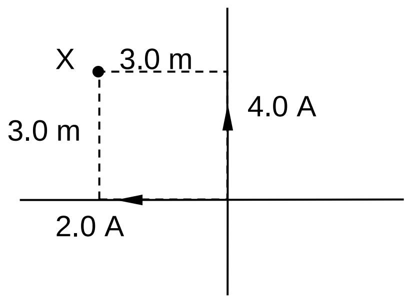
23 A circuit consisting of diodes and resistors is shown below.



Which of the following options correctly show the relative magnitude of the potential differences across the components D_1, R_1 and R_2?

	Greatest to smallest potential difference		
A	D_1	R_1	R_2
B	D_1	R_2	R_1
C	R_1	R_2	D_1
D	R_2	R_1	D_1

24 Two long current carrying conductors are placed perpendicular to each other. The current flowing through one of the wires is 4.0 A upwards, while the current through the other wire is 2.0 A towards the left.



Given that the magnetic flux density of a wire can be calculated with $B = \frac{2 \times 10^{-7} I}{d}$.

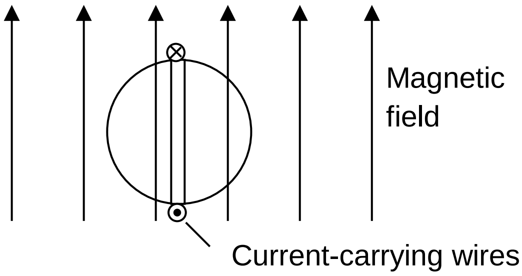
What is the magnitude and direction of the resultant magnetic field at a point X, which is 3.0 m perpendicularly away from both wires? Ignore the Earth's magnetic field.

A 1.33×10^{-7} T out of the plane of the page
B 1.33×10^{-7} T into the plane of the page
C 4.00×10^{-7} T out of the plane of the page
D 4.00×10^{-7} T into the plane of the page

25 Two long parallel wires carry currents of different magniitudes. If the amount of curent in each wire is doubled, what happens to the magnitude of the force between the wires?

A It is quadrupled.
B It is tripled.
C It is doubled.
D It stays the same.

26 A light cylinder with a radius of 0.05 m and a length of 0.20 m is in a region of vertical magnetic field of 0.5 T in strength and direction as shown in the diagram below. The cylinder has 10 turns of wire wrapped around it in the vertical axis.



If the current in the wire is 1 A, the torque acting on the cylinder is

A 0.05 N m clockwise
B 0.05 N m anti - clockwise
C 0.1 N m clockwise
D 0.1 N m anti - clockwise

27 A metallic surface X is irradiated with red light while another identical metallic surface Y is irradiated with violet light of much lower intensity than the red light. Which of the following statements is **false?**

A The stopping voltage for X is lower than for Y.
B The photoelectrons from Y have a higher maximum speed than those from X.
C Y emits more photoelectrons per unit time than X.
D The photons incident on Y have higher energies than those on X.

28 In a series of photoelectric emission experiments, different metal pieces of various work function ϕ were illuminated with monochromatic light of different frequencies f and intensities I. It was found that, for each experiment, the emitted electrons emerged with a spread of kinetic energies up to a certain maximum value. This maximum kinetic energy depends on

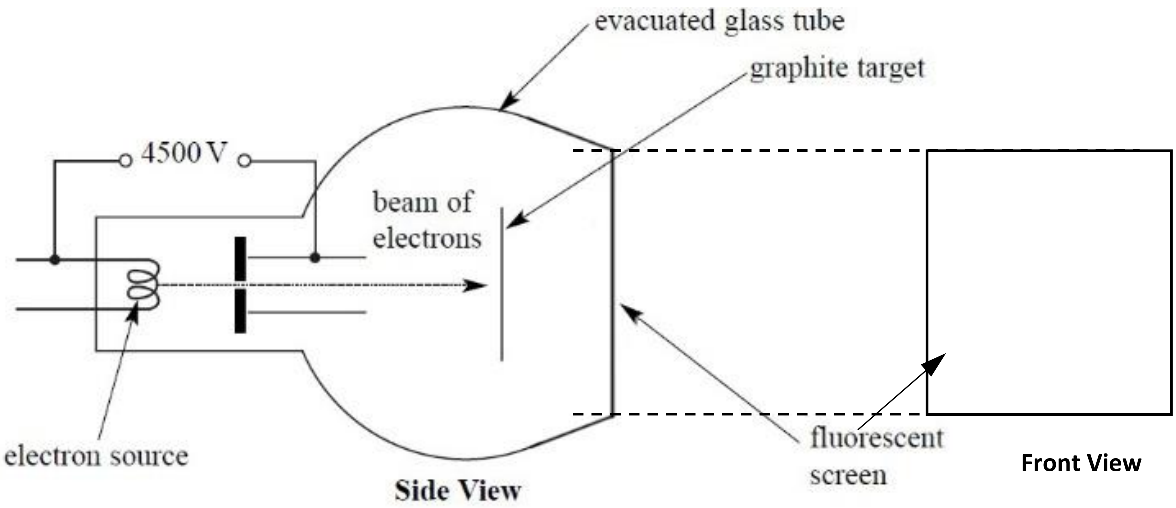
A ϕ but not on f, or I.
B ϕ and I but not on f.
C ϕ and f but not on I.
D ϕ, f, and I.

29 A beam of electrons is incident on a crystal lattice. The regularly spaced parallel planes of ions in the lattice can serve as diffraction grating.

The spacing between each plane is 1 x 10^{-8} m. In order for significant diffraction to occur, the kinetic energy of the each electron should be of the order

A 10^{-34} eV **B** 10^{-26} eV **C** 10^{-21} eV **D** 10^{-2} eV

30 Electrons being fired at a polycrystalline graphite target in a vacuum as shown. The inside surface on the far side of the chamber is coated with fluorescent material that emits light when the electrons release their energy to it.

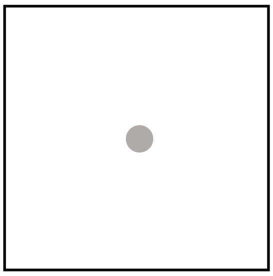


Which of the following shows the correct image seen on the fluorescent screen?

A

Front View

B

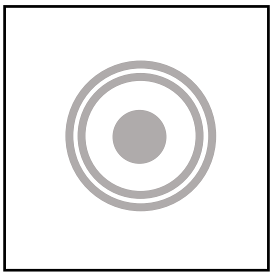


Front View

C

Front View

D



Front View

END OF PAPER

NATIONAL JUNIOR COLLEGE
SENIOR HIGH 2 PRELIMINARY EXAMINATIONS
Higher 1

CANDIDATE NAME

SUBJECT CLASS | REGISTRATION NUMBER

PHYSICS **8866/02**

Paper 2 Structured Questions

Candidate answers on the Question Paper.

25 August 2017

2 hours

No Additional Materials are required.

READ THE INSTRUCTION FIRST

Do not flip over the cover page until you are told to do so.

Write your subject class, registration number and name on all the work you hand in.

Write in dark blue or black pen in the spaces provided on the Question Paper.

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

This paper consists of 2 sections. All answers will be written in spaces provided on the Question Paper.

Section A (40 marks). Answer **all** questions.

Section B (40 marks). Answer **2** questions. **Circle on the cover page the questions you have attempted.**

You are advised to spend about one hour on each section. The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	**/ 6**
2	**/ 9**
3	**/ 6**
4	**/ 7**
5	**/ 12**
Section B	
6	**/ 20**
7	**/ 20**
8	**/ 20**
Total (80m)	

This document contains 19 printed pages, including this cover page.

Data

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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 car is travelling along a horizontal road with speed v. The power P, required to overcome external forces opposing the motion is given by the expression

$$P = cv + kv^3$$

where c and k are constants.

(a) Use base units to obtain an SI unit for the constant *k*.

SI unit for constant *k* = _______________ [2]

(b) For one particular car of 1000 kg, the numerical values, in SI units, of c and k are 240 and 0.98 respectively.
Calculate the power required to enable the car to travel on a horizontal road at 20 m s^{-1}.

Power = _____________W [1]

(c) The car approaches and travels up a slope inclined at 20^0 to the horizontal.

Calculate the power required to maintain the constant speed of 20 m s^{-1}, assuming the car is experiencing the same external resistive force.

Power = _____________W [3]

2 **(a)** Distinguish between *speed* and *velocity*.

....

....

.... [2]

(b) A car is travelling along a straight road at speed v. A hazard suddenly appears in front of the car. In the time interval between the hazard appearing and the brakes on the car coming into operation, the car moves forward a distance of 29.3 m. With the brakes applied, the front wheels of the car leave skid marks on the road that are 12.8 m long, as illustrated in Fig. 2.1.

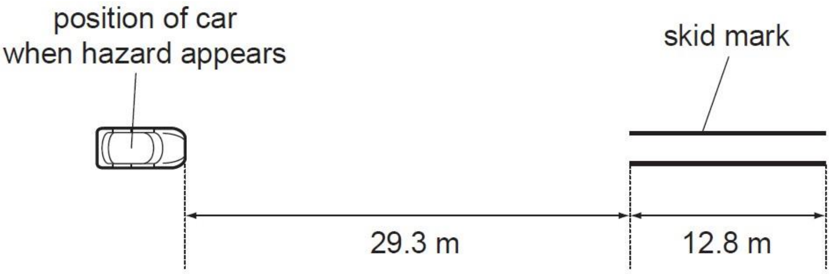

Fig. 2.1

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.

(i) **1.** Show that the speed v of the car before the brakes are applied is 14.6 m s^{-1}. [2]

2. Determine the time interval between the hazard appearing and the brakes being applied.

time = ___________ s [2]

2 **(b)** **(ii)** The legal speed limit on the road is 60 km h^{-1}. Use **both** of your answers in **(b)(i)** to comment on the driver's standard of driving.

....

....

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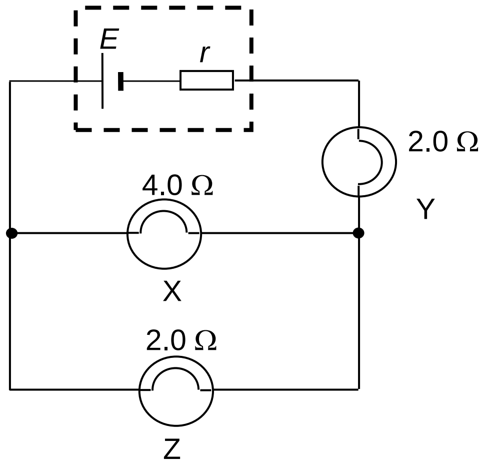
.... [3]

3 A cell of e.m.f. E and internal resistance r is connected to three bulbs X, Y and Z as shown in the circuit of Fig. 3.1.

Fig. 3.1



(a) Calculate the effective resistance of the three bulbs in the circuit of Fig. 3.1.

Effective resistance = ______________Ω [2]

(b) List the light bulbs X, Y and Z in order of *increasing* brightness.

In order of increasing brightness:___________, __________, ___________ [1]

(c) When a voltmeter is placed across the battery in Fig. 3.1, a reading of 3.44 V was obtained, current reading across the battery was 0.93 A. When bulb Y was removed, the voltmeter reading was 2.96 V and the current reading was 1.73 A. Find the e.m.f. E and internal resistance r of the battery.

E = ________________V,

r = _______________Ω [3]

4 A side view of a simple electron gun is shown in Fig. 4.1. When the potential difference between the cathode and the anode is 1200V, the speed with which electrons emerge from the anode of this gun will be about 2×10^7 m s^{-1}.

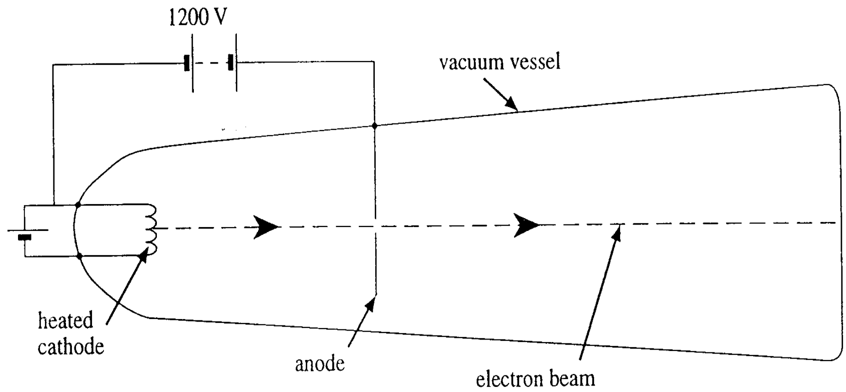
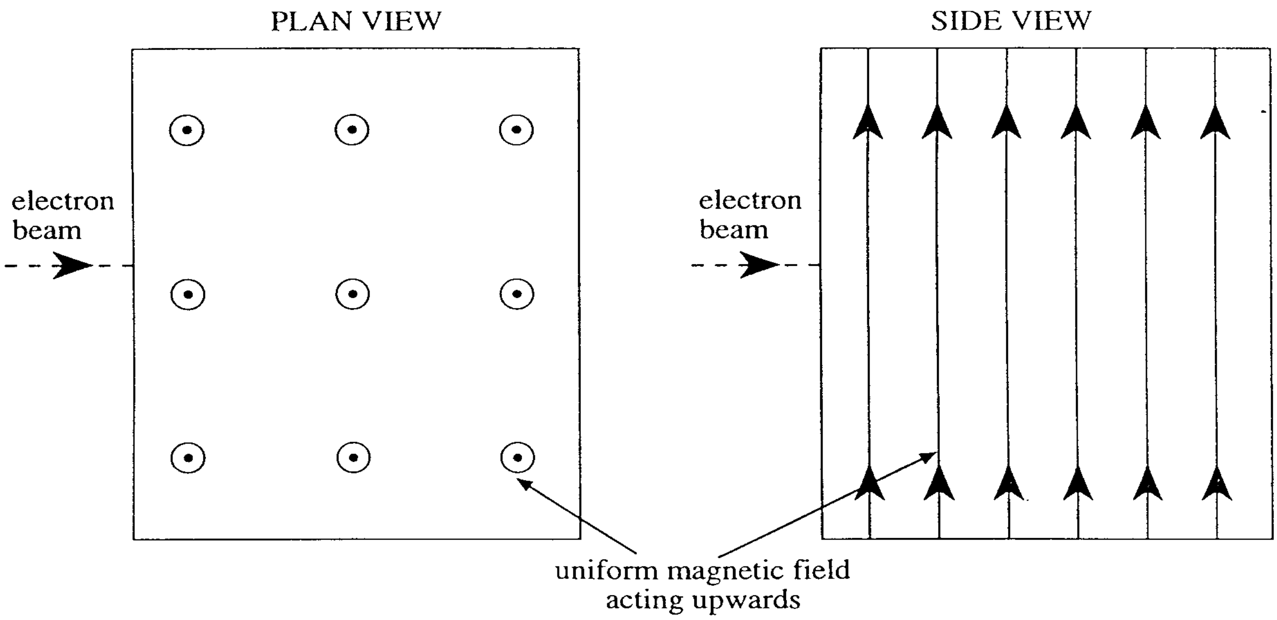


Fig. 4.1

(a) Electrons emerges horizontally from the electron gun and enters a uniform magnetic field which is directed upwards in the plane of the diagram. Calculate the magnitude of the force on an electron in this magnetic field of flux density 0.080 T.

Force = _______________ N [1]

(b) Draw the path of an electron passing through the field described in part **(a)** on each of the two diagrams shown in the figure below. No further calculations are expected. [2]



4 **(c)** **(i)** State and explain whether the speed of an electron changes while it is in the magnetic field.

....

....

.... [2]

(ii) State, with a reason, whether the force on the electron alters while it is in the magnetic field.

....

....

.... [2]

5 Read the following passage and then answer the questions which follow it. (Numbers near to the right-hand margin of the passage indicate the line numbers.)

Lithium solid-state batteries

Lithium solid-state batteries represent a new concept in battery technology. Solid-state means that the liquids and pastes present in ordinary battery systems are replaced by a solid plastic film which cannot leak. This plastic film separates a lithium anode (positive electrode) from a composite cathode (negative electrode) which is in contact with aluminium foil. (See Fig. 5.1) The resultant cell can be constructed so that it has a large electrode area but is less than 0.2 mm thick. It is in many ways similar to a sheet of paper and can be cut and formed into almost any shape. Lithium solid-state cells such as this are rechargeable and can be incorporated into the cases of equipment or into such items as credit cards.

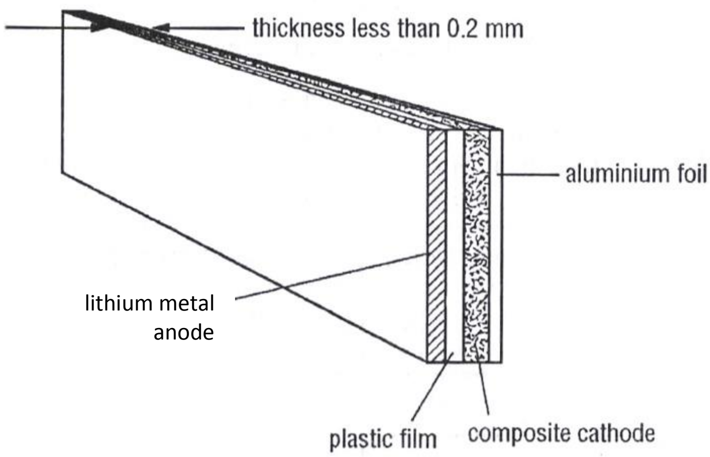


Fig. 5.1

The initial e.m.f. of the cell at full charge is 3.4 V but it rapidly falls to about 2.8 V on load and thereafter falls as shown in Fig. 5.2.

The cell needs to be recharged when the e.m.f. reaches 2.0 V. In practice, its average e.m.f. is 2.5 V.

The current density, energy density and charge capacity all have to be considered for a particular application.

Current density is the amount of current which the lithium cell can provide per unit area of the electrode area. Energy density is the total energy stored in the lithium cell per unit mass of the lithium cell. Charge capacity is the amount of charge available per unit area of the electrode area.

Recommended maximum values:
Discharge current density = 0.15 mA cm^{-2}
Energy density = 120 W h kg^{-1}
Charge capacity = 3.6 C cm^{-1}

Charging one of these cells should be carried out with a constant applied voltage of 3.4 V and with a current density limited to 2.5 mA cm^{-2}. A typical charging current against time graph is shown in Fig. 5.3 for a cell of electrode area 50 cm^{2}.

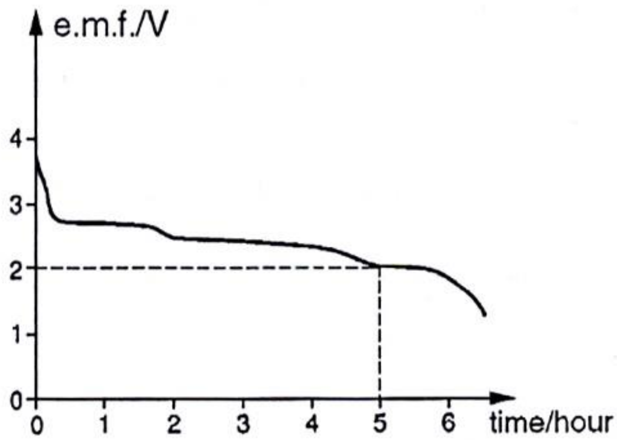


Fig. 5.2

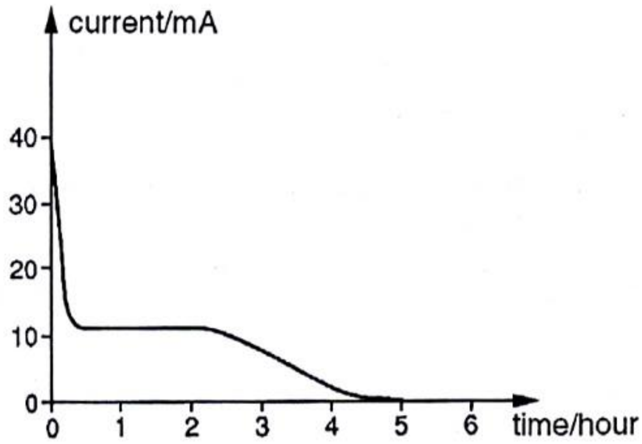


Fig. 5.3

5 **(a)** By reference to lines 9-24 of the passage, answer the following questions for a cell of electrode area 50 cm^2.

(i) Calculate the charge-storage capacity of this cell.

Charge storage capacity = ________ C [1]

(ii) Calculate the recommended maximum value of the discharge current.

Maximum discharge current = ________ mA [1]

(iii) Calculate how long this cell can supply this maximum current.

Time maximum current can be supplied = ___________ s [1]

(iv) Calculate the energy it supplies in this time, assuming that the e.m.f. has a constant value of 2.5 V.

Energy supplied = __________ J [2]

5 **(b)** Fig. 5.3 shows the charging graph for a cell of the same electrode area as in **(a)**.

(i) From the graph, estimate the average charging current over the 5-hour charging time.

Average charging current = __________ mA [2]

(ii) Calculate the energy used in charging the cell.

Energy used in charging the cell = __________ J [2]

(c) Using your answers to **(a)(iv)** and **(b)(ii)**, deduce the electrical efficiency of the charge/discharge cycle.

Electrical efficiency = ____________ [1]

(d) Draw a diagram, using circuit symbols, to illustrate how you would connect a battery of cells which could produce a current up to 300 mA at a voltage of approximately 10 V. In your answer specify the electrode area of the individual cells.

[2]

Section B

Answer **all** the questions in this section

6 **(a)** A uniform metal rod AB of mass 1.5 kg and length 0.50 m is freely pivoted at A as shown in Fig. 6.1.

The end B is suspended by a light spring. The other end of the spring is supported at X. When the rod is in equilibrium, it makes an angle of 30° with the horizontal and the angle between the rod and the spring is 90°.

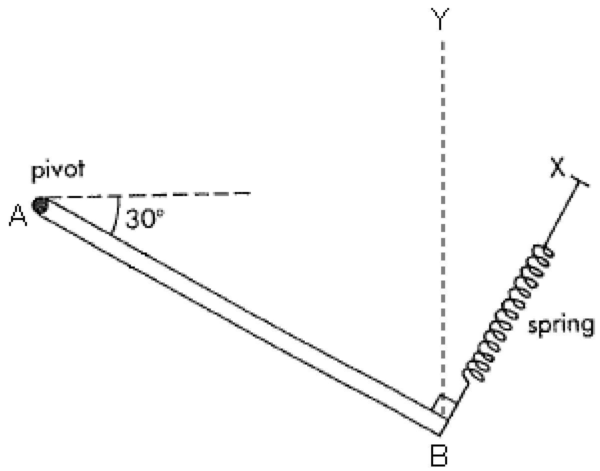


Fig. 6.1

(i) On Fig. 6.1, draw and label the forces acting on the metal rod AB. [2]

(ii) Show that the tension in the spring is 6.4 N. [2]

(iii) Calculate the magnitude and direction of the reaction force at pivot A.

magnitude = ____________ N, direction = __________________________ [4]

6 **(a)** **(iv)** Explain if there will be any change in the tension of the spring if the spring is aligned vertically along YB instead, so that the angle between the lever and the spring is no longer 90°.

....

....

.... [2]

(b) State the principle of conservation of linear momentum.

....

.... [1]

(c) An object A of mass 0.300 kg travelling with a speed 1.5 m s^{-1} collides with another identical object B with a spring of force constant 200 N m^{-1} attached in front as shown in Fig. 6.2. Both objects are originally at rest on a smooth surface.

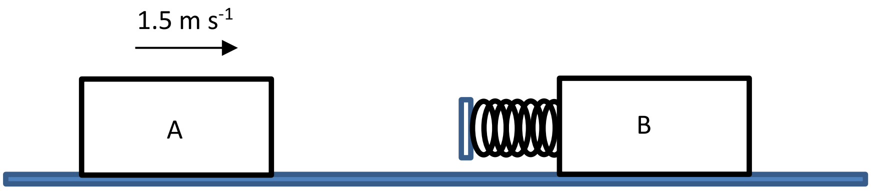


Fig. 6.2

(i) Given that the collision between A and B is elastic, determine the maximum compression of the spring.

Maximum compression = ________________m [4]

6 (c) (ii) Determine with clear working the velocity of A and B after the collision.

Velocity of A = ______________ m s^{-1}

Velocity of B = ______________ m s^{-1} [3]

(iii) The experiment is reset to the initial conditions. B was replaced by another object C which is twice the mass of A. The spring was replaced by a device that attach both mass together upon contact. Determine the new velocity of object A after the collision.

New Velocity of A = ______________ m s^{-1} [2]

7 **(a)** The spectrum of electromagnetic waves is divided into a number of regions such as radio waves, visible light and gamma radiation.

(i) State two distinct features of waves that are common to all regions of the electromagnetic spectrum.

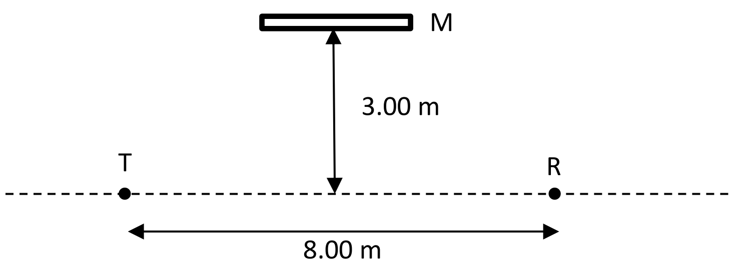
1. ....

2. .... [2]

(ii) State a typical wavelength for x-rays.

.... [1]

(b) The diagram below shows a transmitter T of electromagnetic waves of wavelength λ = 0.40 m. A receiver R is placed 8.00 m away as shown and a plane reflecting surface M is held in such a way that the perpendicular distance from M to the line TR is 3.00 m.



(i) Show that path difference of the waves (from paths TR and TMR) which can reach R from T is 5 λ. [2]

(ii) In reflecting from M, the wave which follows the path TMR undergoes a phase change which is equivalent to it having travelled an extra distance of $\lambda/2$. Determine if the receiver R detected a maximum or a minimum signal. Explain.

....

....

.... [2]

7 **(b)** **(iii)** Describe how the signal received at R varies as M is slowly moved towards the line TR until it almost lies on it.

....

....

....

....

.... [3]

(c) A string is stretched between two fixed points. It is plucked at its centre and the string vibrates, forming a stationary wave as illustrated in Fig. 7.1.v

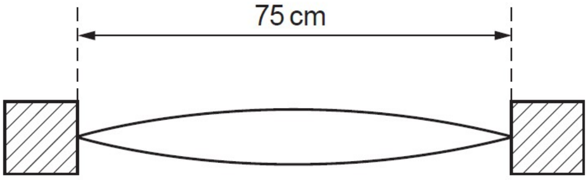


Fig. 7.1

The length of the string is 75 cm.

(i) The frequency of vibration of the string is 360 Hz. Calculate the speed of the wave on the string.

Speed = ___________ m s^{-1} [2]

(ii) By reference to the formation of the stationary wave on the string, explain what is meant by the speed calculated in **(b)(i)**.

....

....

....

.... [3]

7 **(d)** The setup in **(c)** is brought near a tube of water which is filled up to the brim as shown in Fig. 7.2. A tap at the bottom of the tube may be used to release the water in the tube. Determine the length of the air column when the first loud sound is heard. (Speed of sound in air = 330 m s^{-1})

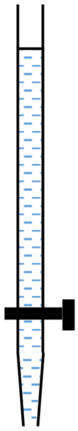


Fig. 7.2

Length of air column = ____________ m [2]

(e) Two ripple tank dippers S_1 and S_2 are vibrating in phase. Draw a series of arcs to represent the wavefronts from S_1 and S_2, using a wavelength such that $S_1S_2 = 3.5\lambda$. [3]
(e.g. make λ =1.0 cm and S_1S_2 = 3.5 cm.)
Mark on your diagram the antinodal lines.

8 **(a)** Explain the terms *ground state, excitation energy* and *ionization energy* as applied to the hydrogen atom. Illustrate your answer with an energy level diagram.

....

....

....

....

....

.... [4]

(b) A student uses a spectrometer and diffraction grating to view a hydrogen emission spectrum. He was able to find maxima for wavelengths of 433 nm, 484 nm and 651 nm.

These emission lines all arise from transitions to the same final state.

(i) Sketch part of the complete energy level diagram relevant to these transitions. Mark in the transitions and identify the three lines. [3]

8 **(b)** **(ii)** How many other transitions could occur between these energy levels?

Number of possible transitions = ______________ [1]

(iii) The energy change for the *least* energetic of these other transitions is 4.8×10^{-20} J. Calculate the wavelength of the corresponding emission line. In which region of the electromagnetic spectrum is it found?

Wavelength = ______________ m [1]

Region of EM spectrum = _________________ [1]

(c) The hydrogen emission spectrum in **(b)** was created through thermal excitation. State, with energy considerations, 2 other ways of that a cool hydrogen gas can be excited.

1. ....

....

....

2. ....

....

.... [2]

(d) Ultraviolet radiation of wavelength 253 nm falls on a zinc surface of work function 3.6 eV.

(i) Determine the maximum kinetic energy of the emitted photoelectrons.

Kinetic energy = ___________________eV [2]

8 **(d)** **(ii)** Determine the corresponding de Broglie wavelength of the emitted photoelectrons.

Wavelength = ________________m [1]

(iii) Explain why the maximum possible kinetic energy of a photoelectron is independent of the intensity of the incident light

....

....

....

.... [2]

(iv) The surface area of the zinc surface is 7.5 cm^2. The intensity of the UV radiation at the surface is 60 mW m^{-2} and it is assumed that 1% of the photons emit electrons from the surface. Determine the photoelectric current.

Current = __________________A [3]

------------------------ End of Paper ---------------------

2017 NJC SH2 Prelim H1 Physics Suggested Solution

Paper 1

1	B	11	C	21	A
2	D	12	C	22	B
3	A	13	C	23	B
4	C	14	D	24	A
5	B	15	B	25	A
6	C	16	C	26	C
7	C	17	A	27	C
8	C	18	C	28	C
9	B	19	D	29	D
10	D	20	B	30	D

Paper 2

1. (a) Units of P = units of kv^3
Power P = Energy / time = Force x displacement / time
Units of k = units of P / units of v^3
= kg m^2 s^{-3} / m^3 s^{-3}
= kg m^{-1}

(b) P = 240 v + 0.98 v^3
= 240 (20) + 0.98 $(20)^3$ = 12640 W = 12700 W

(c) On a horizontal road,
R = F = P/v = 12640 / 20 = 632 N
On the slope,
F'= R + mg sinθ = 632 + (1000)(9.81) sin 20° = 3987.2 N
P'= F'v = 3987.2 x 20 = 7.97 x 10^4 W

2. (a) (i) speed is only the magnitude of velocity.
velocity has a stated direction as well.

(b) (i)1. $v^2 = u^2 + 2as$
$0 = u^2 + 2 \times (-0.85 \times 9.81) \times 12.8$
v = 14.6 m s^{-1}

(i)2. s = ut
29.3 = 14.6 t

t = 2.0 s

2. (b) (ii) 60 km h^{-1} = 16.7 m s^{-1} or 14.6 m s^{-1} = 53 km h^{-1}
Thus he is driving within speed limit.
The driver's reaction time is too slow though OR the braking distance is too long.

3. (a) $R_{eff} = \left(\frac{1}{4.0} + \frac{1}{2.0}\right)^{-1} + 2.0 = 3.33\Omega$

(b) X, Z, Y.

The brightness of the bulbs depends on the power dissipated in them. Comparing bulbs X and Z, since they are in parallel, the voltage drop across them is the same, and using $P = V^2/R$, we conclude that bulb Z is brighter than bulb X.

Next, use $P = I^2R$ to compare between bulbs Y and Z, and bulb Y is brighter as the current through Y is larger.

(c) E = 0.93r + 3.44 -----(1)

E = 1.73r + 2.96 ------(2)

(2) – (1)

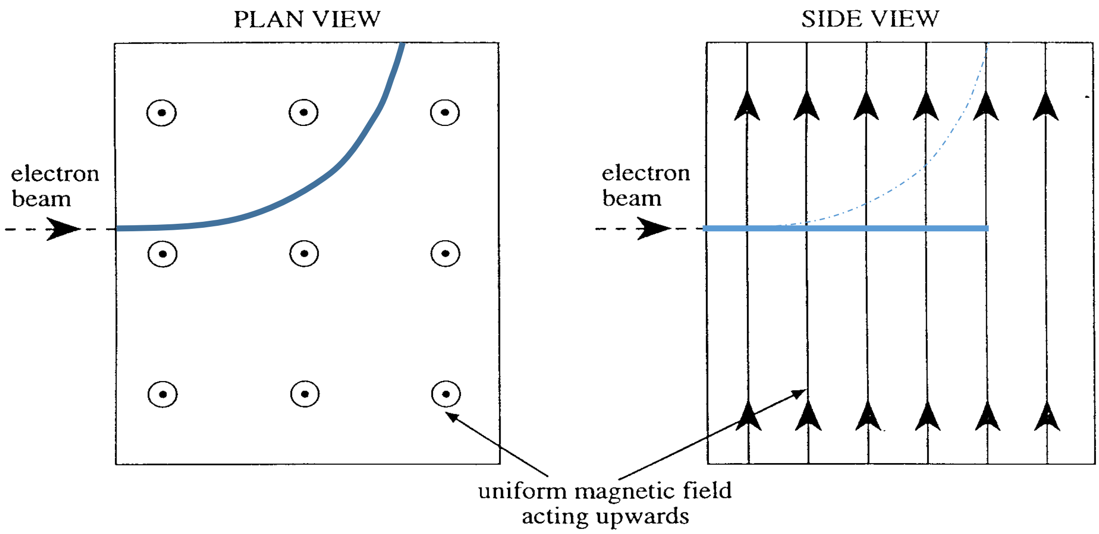
0 = 0.8r – 0.48

r = 0.6 Ω ---------------- sub into (1)

E = 4.00 V

4. (a) F = Bqv = (0.080)(1.6 x10^{-19})(2x10^7) = 2.56 x 10^{-13} N

(b)



(c) (i) As the magnetic force on the electron is perpendicular to it's direction of motion, there is not change in the magnitude of velocity, hence speed remains unchanged.

(ii) The magnitude of magnetic force on the electron depends on the magnetic flux density, charge as well as the speed of the electron, since these are constant, the magnitude of the magnetic force does not change. However, the direction of the magnetic force is perpendicular to the motion of the electron. Since the direction of motion changes (due to the force), the direction of magnetic force changes.

5. (a) (i) $3.6 \times 50 = 180\ C$

(ii) $0.15 \times 50 = 7.5\ mA$

(iii) $I = \frac{Q}{t}$

$$t = \frac{Q}{I} = \frac{180}{7.5 \times 10^{-3}} = 24000\ s$$

(iv) $P = IV = 2.5 \times 7.5 \times 10^{-3} = 0.01875W$

$E = Pt = 0.01875 \times 24000 = 450J$

(b) (i) Average current = area / total time

= (7.5+20+12.5)/5=8 mA

(ii) $P = IV = 8 \times 10^{-3} \times 3.4 = 0.0272W$

$E = Pt = 0.0272 \times 5 \times 60 \times 60 = 490\ J$

(c) Efficiency $= \frac{energy\ during\ charging}{energy\ during\ discharing} \times 100\%$

$$= \frac{450}{490} \times 100\% = 92\%$$

(d) Show 4 cells in series. Each cell will produce 2.5 V so total is 10 V

State area is 2000 cm^2 to get 300 mA.

6. (a) (i) Weight, tension, reaction force, all 3 forces intersecting

(ii) Using the principle of moments and choosing A as the pivot,
Anticlockwise moment of tension = clockwise moment of weight of rod
$T \times 0.50 = W\cos30° \times 0.25$
$T \times 0.50 = 1.5 \times 9.81 \times \cos30° \times 0.25$
$T = 6.4$ N

(iii) Resultant force is zero hence horizontal component of reaction force is equal to horizontal component of tension.
Horizontal component of reaction force = 6.4 sin30°=3.2 N to the left
Vertical component of reaction force + vertical component of tension = weight
Vertical component of reaction force = 1.5×9.81-6.4 cos30°=9.17N upwards

Reaction force = $\sqrt{3.2^2 + 9.17^2} = 9.7N$

$tan\theta = \frac{9.17}{3.2} \rightarrow \theta = 71°$ clockwise above the horizontal

(iv) The clockwise moment provided by weight remains unchanged.
For the rod to be in equilibrium, the net moment must zero. Since the perpendicular distance between tension and the pivot A is reduced when the tension is along YB, the tension must increase.

(b) Principle of Conservation of Momentum states that if there is no resultant external force acting on a system of bodies, the total linear momentum of the system in any direction always remain constant.

(c) (i) For maximum compression, the system should be moving at the same speed.
By Principle of conservation of linear momentum,

$M_A u_A = (M_A + M_B)\ v$
$(0.300)(1.5) – (0.300 + 0.300)v$
$V = 0.75$ m s^{-1}

Gain in elastic potential energy = Loss in kinetic energy

$\frac{1}{2} k x^2 = \frac{1}{2} M_A u_A^2 – \frac{1}{2} (M_A + M_B) v^2$
$\frac{1}{2} (200)x^2 = \frac{1}{2} (0.300)(1.5)^2 – \frac{1}{2} (0.600)(0.75)^2$
$x = 0.041$ m

(ii) By Principle of conservation of linear momentum,

$M_A u_A = M_A v_A + M_B v_B$
$1.5 = v_A + v_B$ ------------(1)

Relative speed of approach = Relative speed of separation

$u_A – u_B = v_B – v_A$
$1.5 = v_A + v_B$ -----------(2)

(1) – (2), $v_A = 0$ m s^{-1}
$v_B = 1.5$ m s^{-1}

(iii) By Principle of conservation of linear momentum,

$M_A u_A = (M_A + M_C)\ v$
$(0.300)(1.5) = (0.300 + 0.600)v$
$v = 0.50$ m s^{-1}

7. (a) (i) 1. EM waves are transverse waves.

2. EM waves can be transmitted through a vacuum.

3. EM waves travel at the speed of light [Any 2]

(ii) 0.01 nm to 10 nm

(b) (i) path difference Δx = TMR – TR

= (5+5) – 8 = 2 m = (2/0.4)λ = 5 λ

(ii) Since there is a phase change after reflecting from M, the total path difference of the two ways is 5 ½ λ. This meets the criteria for destructive interference and hence a minimum signal is detected.

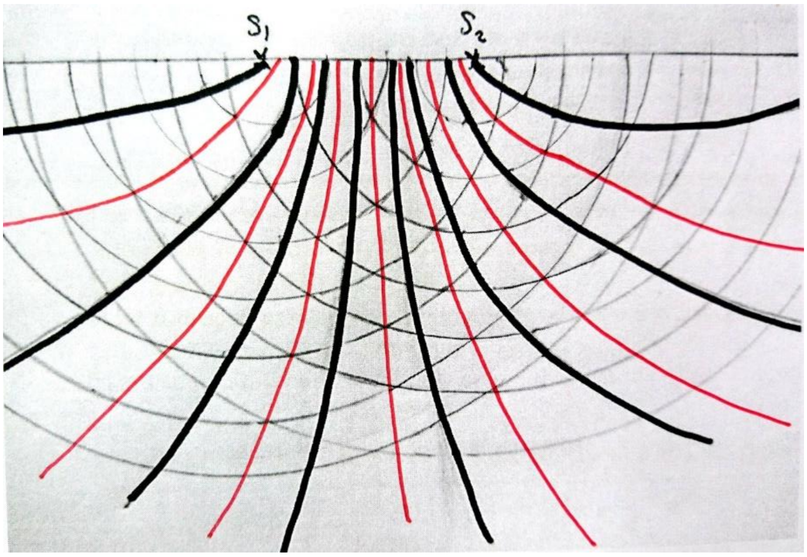
(iii) As M is move towards the line TR, the path difference of the signals will decrease. There will be a variation of maximum and minimum signal detected. When the total path difference is of the value n λ where n = 1,2,3,4,5 a maximum signal will be detected (i.e. there will be 5 maxima detected). When the total path difference is of the value (2n – 1)/2 λ, a minima signal will be detected.

(c) (i) wavelength = 2 x 75 cm = 150 cm
$v = f\lambda$= 360 x 1.50 = 540 m s^{-1}

(ii) When the string is plucked, it sent a wave traveling in the string. This wave hits the fixed end, gets reflected, and superpose with itself to form the stationary wave. The wave mentioned, travels at a speed that was calculated in (b)(i).

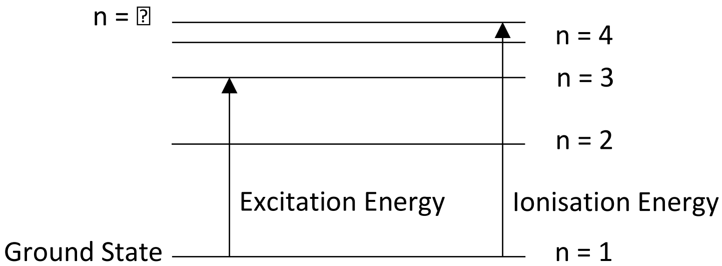
(d) $v = f\lambda$
330 = 360 x λ
λ = 0.92 m
Since it is the fundamental mode,
the length of the air column = ¼ λ = 0.23 m

(e)



Red lines (anti-nodal) Black lines (nodal)

8. (a)

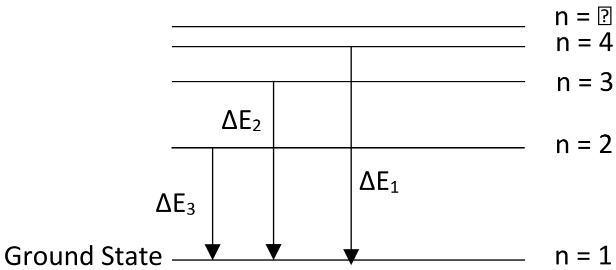


Ground State is the lowest energy state of an atom. This is the state where the atom is the most stable.

The amount of energy required for an electron in the hydrogen atom to be excited to a higher energy state (e.g. from n = 1 to n = 2 or n = 2 to n = 3) is called the excitation energy.

The amount of energy required for an electron in the hydrogen atom to ionised (removed infinitely far away from the hydrogen atom) is the ionisation energy.

(b) (i)



$\Delta E = hc/\lambda$

$\Delta E_1 = hc/(432.8 \times 10^{-9}) = 2.87$ eV

$\Delta E_2 = hc/(483.8 \times 10^{-9}) = 2.57$ eV

$\Delta E_3 = hc/(651.1 \times 10^{-9}) = 1.91$ eV

(ii) Total number of possible transitions = ${}^4C_2 = 6$

Hence Number of other transitions = 6-3 = 3

(iii) Least energetic transition will be from n = 4 to n = 3

$\Delta E = hc/\lambda = (2.87 - 2.57) \times 1.6 \times 10^{-19}$ J

$\lambda = 4.14 \times 10^{-6}$ m (infra-red spectrum)

(c) 1. Cool hydrogen gas can be excited by collisions will electrons or other atoms. During the collision, the electron in the hydrogen atom will gain energy equal to the energy difference in energy levels from the kinetic energy of the particle. The rest of the kinetic energy remains with the particle.

2. Cool hydrogen gas can also be excited by radiating it with photons of energies which are equal to the energy difference in energy levels.

(d) (i) $hf = \phi + \frac{1}{2} mv^2$

$\frac{1}{2} mv^2 = hf - \phi = hc/(253 \times 10^{-9} \times 1.6 \times 10^{-19}) - (3.6 \text{ eV}) = 1.31$ eV

(ii) $p^2/2m = E_k \Rightarrow p^2 = 2mE_k$

$\lambda = h/p = h/(2mE_k)^{1/2} = h/(2 \times 9.11 \times 10^{-31} \times 1.31 \times 1.6 \times 10^{-19})^{1/2} = 1.07 \times 10^{-9}$ m

(iii) When the photons are incident on the metal surface, the energy of the photon is used to overcome the work function of the metal surface while the rest of the energy will be passed to the emitted photoelectron as its kinetic energy. As each electron can only absorb one photon, the intensity of the incident light (which determines the number of incident photons), does not affect the maximum kinetic energy of the photoelectron.

(iv) Power = Intensity x Area = Energy/ time

$$I \times A = (n_p/t)\,(hc/\lambda)$$

$$(60 \times 10^{-3})(7.5 \times 10^{-4}) = (n_p/t)(\,hc/\,253 \times 10^{-9})$$

$n_p/t = 5.724 \times 10^{13}$ photons per second

$n_e/t = 5.724 \times 10^{13} \times 0.01 = 5.724 \times 10^{11}$ electrons per second

Current = $Q/t = q(n_e/t) = (1.6 \times 10^{-19})(5.724 \times 10^{11}) = 9.16 \times 10^{-8}$ A