H

Anglo-Chinese Junior College

JC2 Physics Preliminary Examination
Higher 1

A Methodist Institution
(Founded 1886)

PHYSICS **8866/01**
Paper 1 Multiple Choice **29 August 2017**

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

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your Name and Index number in the Answer Sheet provided.

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

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-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
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	=	$\rho g h$
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

1 What is the best estimate of the total number of beats a human heart makes in the life expectancy of the average Singaporean?

A 3×10^8 **B** 8×10^8 **C** 3×10^9 **D** 8×10^9

2 When comparing systematic and random errors, which of the following applies to random errors?

P_1: error can be eliminated
P_2: error cannot be eliminated
Q_1: error is of constant sign and magnitude
Q_2: error is of varying sign and magnitude
R_1: error will be reduced by averaging repeated measurements
R_2: error will not be reduced by averaging repeated measurements

A P_1, Q_1, R_2

B P_1, Q_2, R_2

C P_2, Q_2, R_1

D P_2, Q_1, R_1

3 A car accelerates uniformly from rest and reaches a speed of 30 m s^{-1} in 50 m.

If it continues to accelerate at the same rate, what is the time taken for it to travel another 250 m?

A 4.8 s **B** 7.5 s **C** 11.5 s **D** 14.6 s

[Turn over

4 A ball is thrown upwards vertically with an initial speed u and travels back to its original position with a final speed v. The time taken for it to travel upwards is t_{up} and the time taken for it to travel downwards is t_{down}.

If air resistance is **not** negligible, which of the following is true?

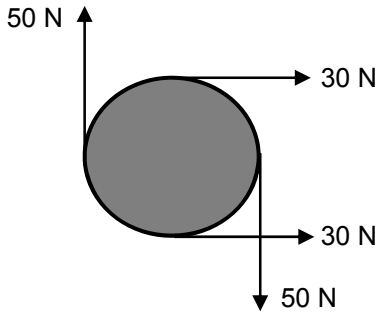
	time taken	speed
A	$t_{up} < t_{down}$	$u = v$
B	$t_{up} > t_{down}$	$u = v$
C	$t_{up} < t_{down}$	$u > v$
D	$t_{up} > t_{down}$	$u < v$

5 Different types of resultant force acts on different bodies in different situations.

Which row in the table shows the incorrect resultant force acting on the body when it experiences an action (indicated in **bold**)*?*

	body	action	resultant force on the body
A	A small metal ball	**rebounding** from the floor after falling vertically from a height	vector sum of normal contact force of floor on ball and weight of ball
B	A tennis ball	travelling horizontally and **rebounding** after hitting a vertical wall	normal contact force of wall on ball
C	The moon	**orbiting** around the earth	gravitational force of earth on moon
D	A suspended pendulum bob	**oscillating** in a to-and-fro motion	force of string on bob

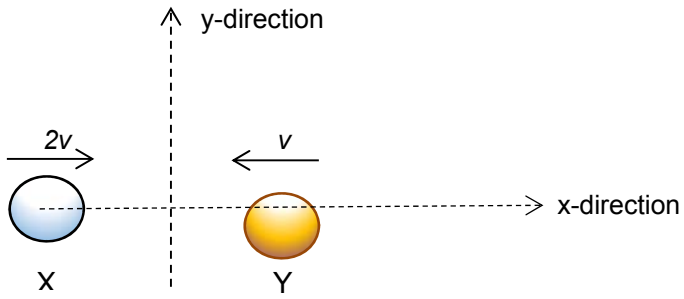
6 The diagram shows four forces applied to a circular object.



Which row in the table shows the resultant force and resultant torque acting on the body?

	resultant force	resultant torque
A	zero	zero
B	zero	non-zero
C	non-zero	zero
D	non-zero	non-zero

7 Two identical smooth spheres X and Y have masses *m* and *3m*. They are projected on a smooth horizontal plane with speeds *2v* and *v* respectively towards each other. The two masses are involved in an elastic collision that is not head-on as shown.



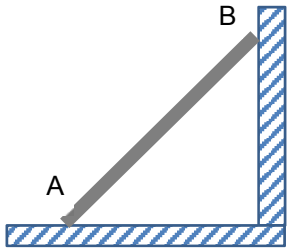
Which row in the table is correct?

	total momentum before impact in the x-direction	total momentum after impact in the y-direction
A	*mv* to the left	zero
B	*mv* to the right	zero
C	*mv* to the left	non-zero

[Turn over

D	*mv* to the right	non-zero

8 A uniform ladder is resting on a vertical wall. Friction between the ladder and the ground and also between the ladder and the wall prevents the ladder from slipping.

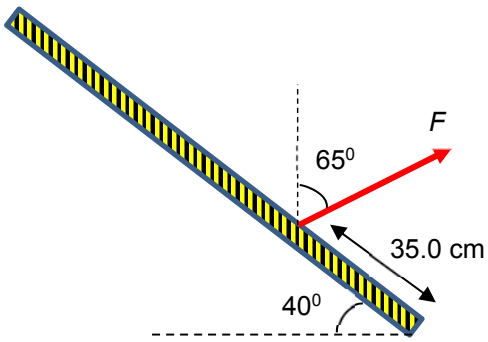


Which row in the table shows the direction of the contact forces on the ladder at points A and B?

	at point A	at point B
A		
B		
C		
D		

9 As shown in the figure below, a 2.0 m long uniform fishing rod has a mass of 126 g. With his right hand, the man grips the handle at a distance 35.0 cm from one end of the rod and exerts a force *F* at an angle 65° from the vertical. The fish is 500 g and hangs motionless at the other end of the rod.

Source: www.123RF.com



What is the value of *F*?

A 2.7 N **B** 3.0 N **C** 14.5 N **D** 26.7 N

10 A submarine is cruising in the ocean at a constant depth of 50 m.

To balance the submarine's weight, there is a resultant upward vertical force on the submarine due to the water.

What is the physical reason for this resultant upward vertical force?

A The thrust of the submarine's propellers.

B The density of the water increases with depth.

C The drag force experienced by the submarine.

D The pressure of the water increases with depth.

11 Which row in the table describes the possible motion of a charge for it to experience both an electric force and a magnetic force?

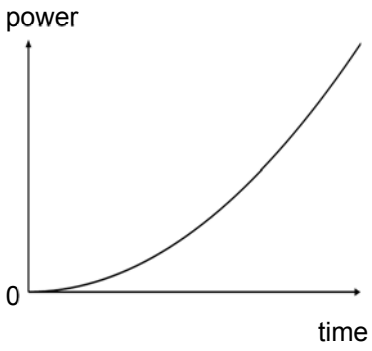
	electric field	magnetic field
A	charge is moving perpendicular to the electric field	charge is stationary
B	charge is stationary	charge is moving parallel to the magnetic field
C	charge is stationary	charge is moving not parallel to the magnetic field
D	charge is moving parallel to the electric field	charge is stationary

[Turn over

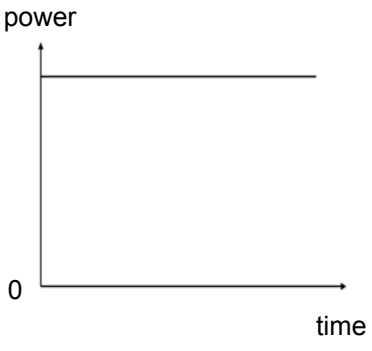
12 A constant force is applied on a box resting on a frictionless surface.

Which of the following graphs best represents the variation of power supplied with time?

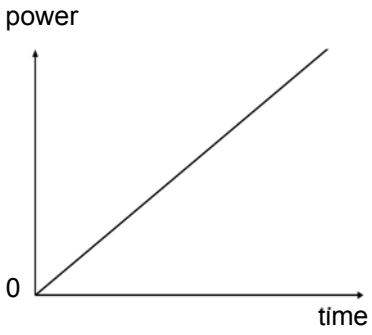
A



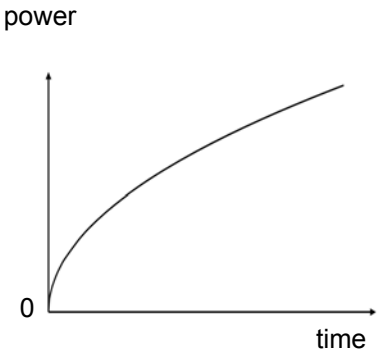
B



C



D



13 A girl on a swing is 2.5 m above the ground at the maximum height and at 1.5 m above the ground at the lowest point.

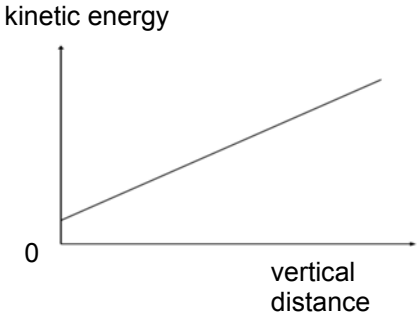
What is the maximum velocity of the swing?
(take g = 10 m s^{-2})

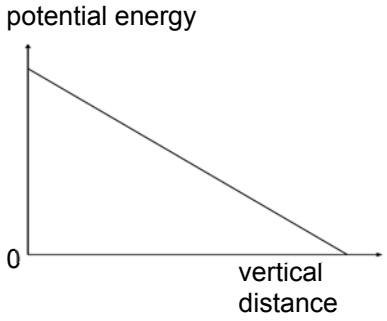
A $5\sqrt{2}$ m s^{-1} **B** $2\sqrt{5}$ m s^{-1} **C** $2\sqrt{3}$ m s^{-1} **D** $3\sqrt{2}$ m s^{-1}

14 A stone was projected horizontally off a cliff as shown. Air resistance is negligible.

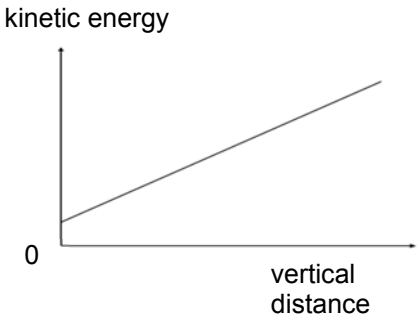
Which graphs represents the variation with the vertical distance of kinetic energy and gravitational potential energy of the stone?

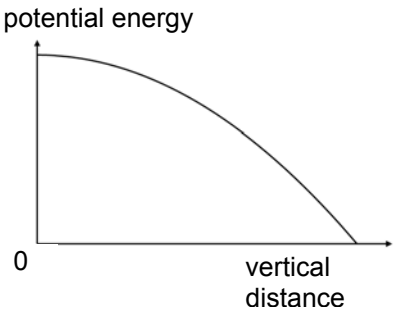
A



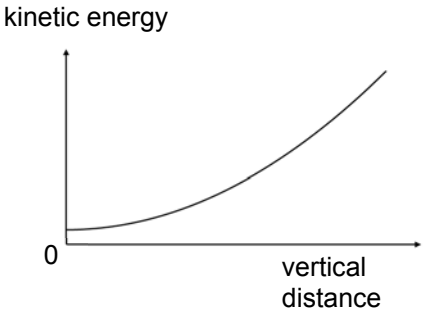


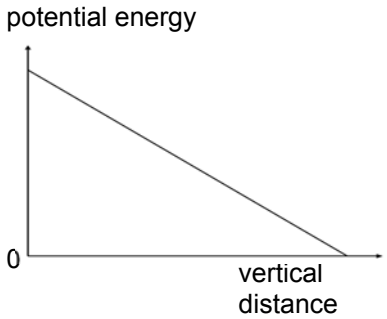
B



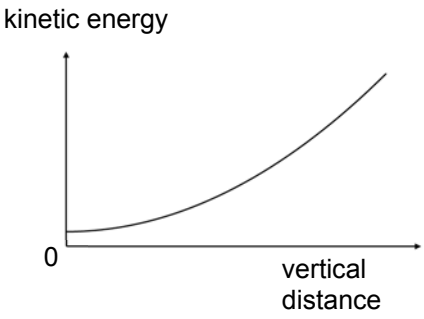


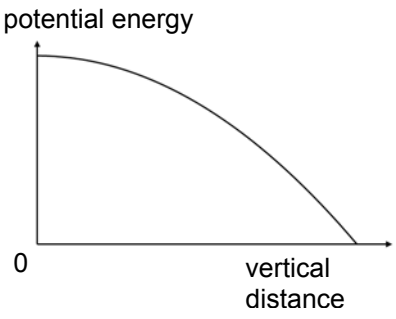
C





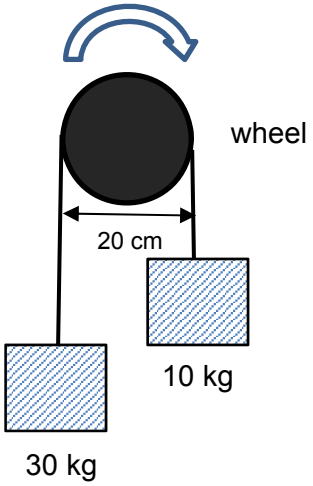
D





[Turn over

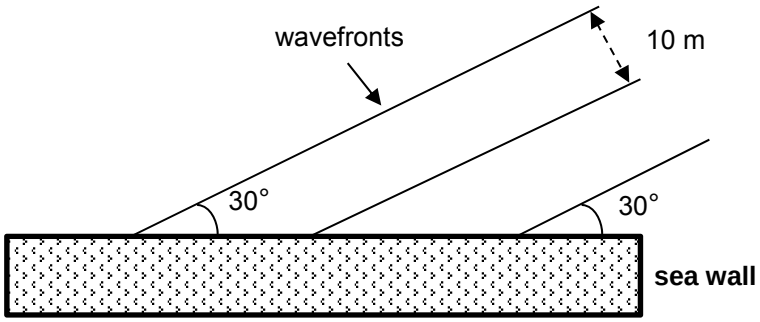
15 Two masses, 10 kg and 30 kg are attached to a light belt which hangs over a wheel that is mounted to the axle of an electric motor as shown. The belt is stationary and the wheel has a diameter of 20 cm. The motor has an efficiency of 70% and the wheel is rotating clockwise at a constant rate of 30 revolutions per minute.



What is the input power to the motor?

A 62 W **B** 88 W **C** 3700 W **D** 5280 W

16 Parallel water waves of wavelength 10 m strike a straight sea wall. The wavefronts make an angle of 30° with the wall as shown.



What is the phase difference at any instant between the waves at two points that are 5 m apart along the wall?

A 30° **B** 45° **C** 90° **D** 180°

17 Which of the following effects provides direct experimental evidence that light is a transverse wave rather than a longitudinal wave?

A Light can undergo diffraction and reflection.

B We can hear but not see around a corner.

C Intensity of light from a point source falls off inversely with the square of the distance.

D Glare reflected off the water surface of the lake is reduced by using sunglasses.

18 A string is set to vibrate between two fixed ends and a single antinode is observed between the fixed ends at a frequency of 225 Hz.

Which of the following is true when the same string is vibrating at 900 Hz?

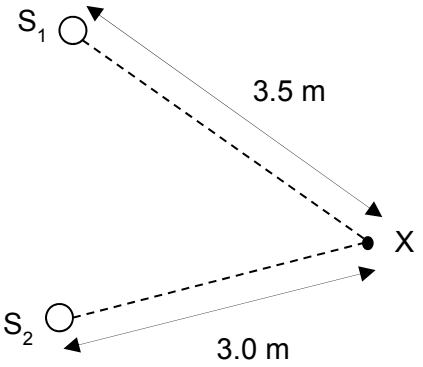
A It has 3 more nodes than the original wave.

B No stationary wave is observed.

C Its wavelength is 4 times the original wavelength.

D Its wave speed has increased by 4 times.

19 Two wave generators S_1 and S_2 produce water waves of wavelength 1.0 m. A detector is placed on the water surface at point X which is 3.5 m from S_1 and 3.0 m from S_2 as shown in the diagram. Each generator produces a wave of amplitude *A* at X when operating alone. The generators are operating together and producing waves which have a constant phase difference of π radians.



The resultant amplitude at X is

A 0 **B** *A*/2 **C** *A* **D** *2A*

[Turn over

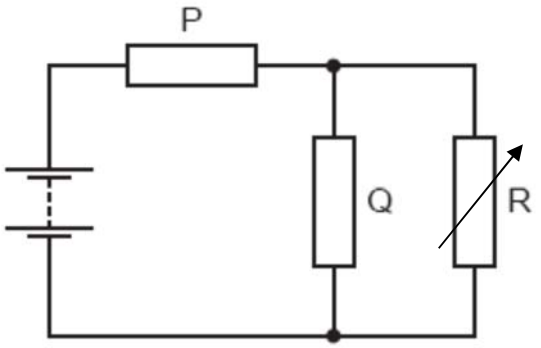
20 Which are the definitions of potential difference and e.m.f. in terms of energy transfer W and charge q?

	potential difference	e.m.f.
A	$\frac{W}{q}$	$\frac{W}{q}$
B	Wq	Wq
C	$\frac{W}{q}$	Wq
D	Wq	$\frac{W}{q}$

21 Which row in the table describes how the resistance of the electrical components varies when the potential difference across each component increases?

	semiconductor diode	filament lamp	metallic conductor at constant temperature
A	constant	decreases	increases
B	decreases	increases	increases
C	decreases	increases	constant
D	Increases	constant	decreases

22 The resistors P and Q in the circuit have equal resistance. R is a variable resistor.



If the battery has negligible resistance, which of the following statements is correct?

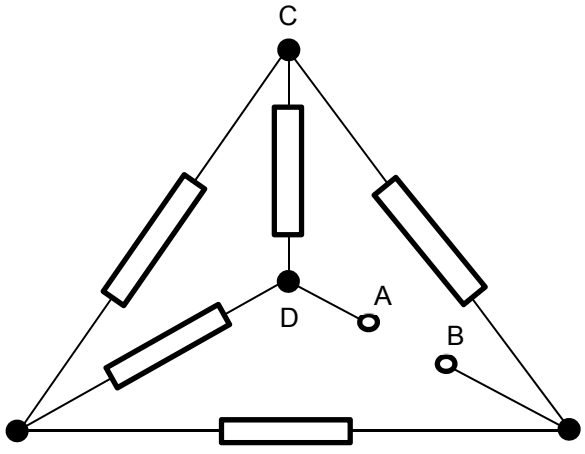
A The current supplied by the battery is fixed regardless of the value of R.

B The potential difference across P increases when R changes from 2 Ω to 4 Ω.

C There will always be an equal amount of current flowing through Q and R regardless of the value of R.

D The current in P is maximum when R is 0 Ω.

23 Five equal resistors, each of resistance *R*, are connected as shown. A battery of negligible internal resistance and e.m.f. *V* is connected between A and B.

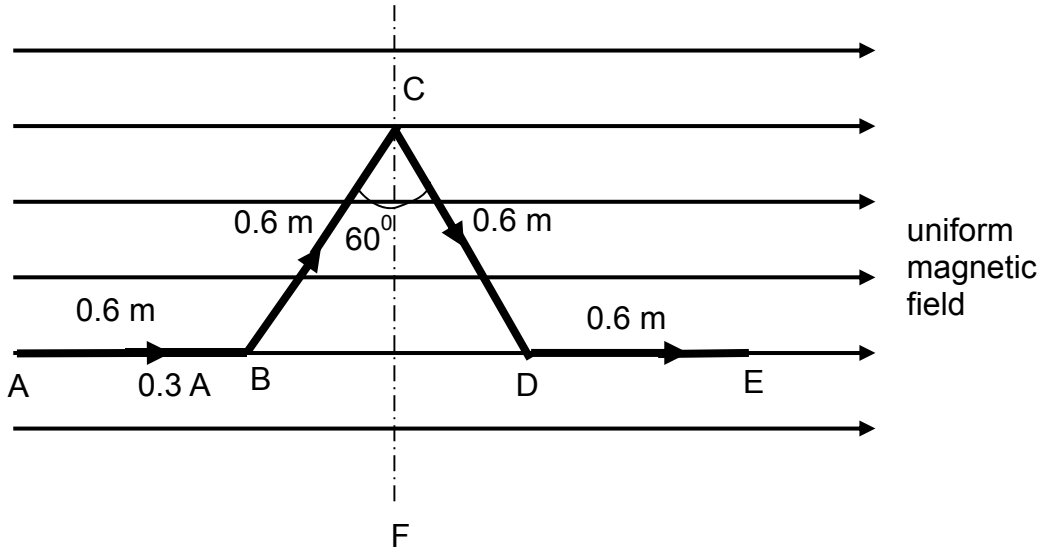


What is the current flowing in CD?

A $\frac{V}{R}$ **B** $\frac{V}{2R}$ **C** $\frac{2V}{R}$ **D** $\frac{2V}{3R}$

[Turn over

24 A current of 0.3 A flows in a conductor ABCDE that lies on the plane of the paper as shown.

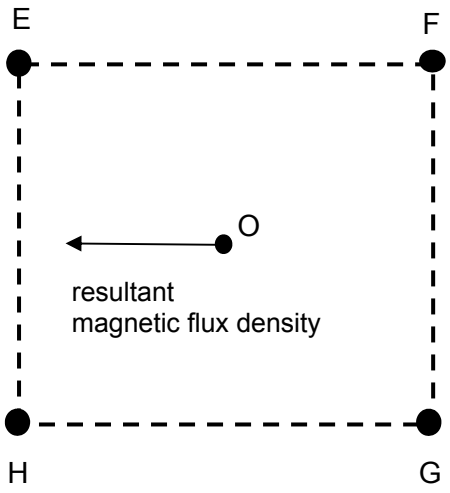


The conductor is inside a region of a uniform magnetic field having a magnetic flux density of 1.5 T. AB and DE are parallel to the magnetic field. Angle BCD is 60°. The lengths of segments AB, BC, CD and DE are 0.6 m each.

Which row in the table describes the resultant force and resultant torque on the conductor?

	resultant force	resultant torque (when viewed from the top)
A	0 N	clockwise about axis CF
B	0 N	no resultant torque
C	0.47 N	anti-clockwise about axis CF
D	0.47 N	no resultant torque

25 Four parallel conductors, carrying equal currents, pass vertically through the four corners of a square EFGH as shown in the diagram. In two conductors, the current is directed into the page. In the other two conductors, the current is directed out of the page.

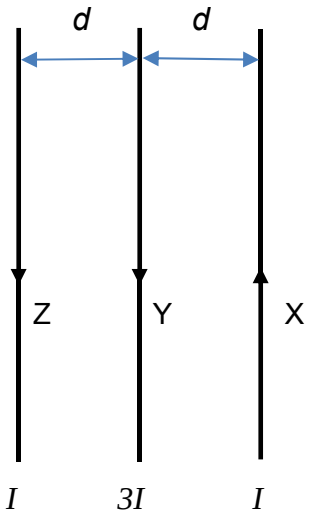


In order to produce a resultant magnetic flux density at O in the direction shown, which row in the table shows the correct directions of the currents?

	current into the page	current out of the page
A	E and F	G and H
B	E and H	F and G
C	F and H	E and G
D	G and H	E and F

[Turn over

26 Three long wires X, Y and Z are placed parallel to each other and equally spaced apart as shown in the diagram. Wires Z and Y carry current downwards and wire X carries current upwards.



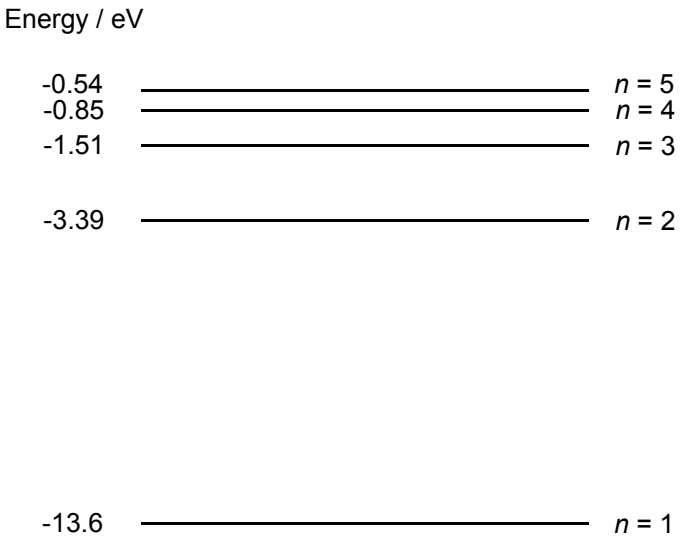
When wire X and Z are placed a distance *d* apart and each wire carries current I, each wire exerts a force per unit length *F* on the other wire.

What is the direction and magnitude of the net force per unit length acting on wire Z in the diagram?

[The force per unit length is given by $F = \frac{\mu_0 I_1 I_2}{2 \pi d}$, where I_1 and I_2 are the currents in the two parallel wires and *d* is the separation between the wires]

	magnitude of net force per unit length on wire Z	direction of net force per unit length on wire Z
A	F	away from Y
B	F	towards Y
C	$\frac{5}{2}F$	away from Y
D	$\frac{5}{2}F$	towards Y

27 The lowest five energy levels of a hydrogen atom are shown below. The electron is initially at $n = 1$.



A free electron with kinetic energy of 12.6 eV bombards the hydrogen atom.

What is the largest wavelength of light emitted?

A There are no photons emitted.

B 103 nm

C 122 nm

D 661 nm

28 A monochromatic beam of electromagnetic radiation is incident on a metal and electrons are emitted.

If the wavelength of the monochromatic radiation is halved but the number of incident photons per unit time is maintained, which of the following quantities is doubled?

A work function of the metal

B momentum of the photons

C maximum kinetic energy of the electrons

D number of electrons emitted per unit time

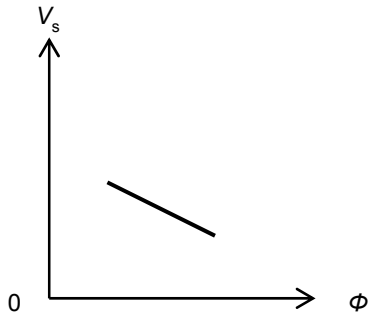
[Turn over

29 A beam of electrons and a beam of protons are accelerated across the same potential difference. They each then undergo diffraction through a crystal lattice to determine their de Broglie wavelength. The de Broglie wavelength of the electron is found to be 3.9×10^{-9} m.

What is the theoretical de Broglie wavelength of the proton?

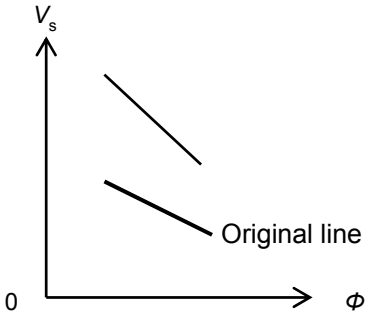
A 2.1×10^{-12} m **B** 9.1×10^{-11} m **C** 3.9×10^{-9} m **D** 1.7×10^{-7} m

30 Electromagnetic radiation of a fixed wavelength is incident on different metals. The stopping potential V_s for each metal is plotted against the work function Φ of each metal to obtain the following graph.

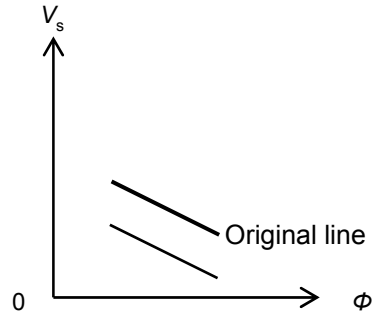


If both the wavelength and the intensity of the electromagnetic radiation is doubled, which of the following graphs reflects this change?

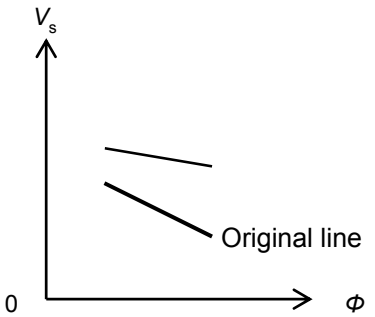
A



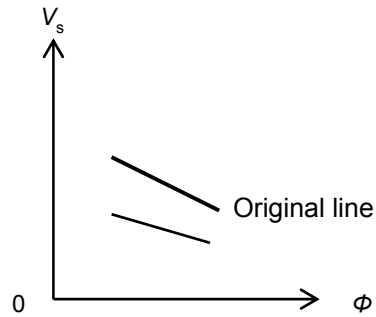
B



C



D



J2 H1 Physics
Preliminary Examination P1 Guide

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

H

Anglo-Chinese Junior College

JC2 Physics Preliminary Examinations
Higher 1

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CANDIDATE NAME		FORM CLASS	
CENTRE NUMBER	S 3 0 0 4	INDEX NUMBER	

PHYSICS

8866/02
11 August 2017

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

2 hours

READ THESE INSTRUCTIONS FIRST

Write your index number, name and form class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

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

Section A
Answer **all** questions.

Section B
Answer any **two** 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 Only	
Section A	
1	/ 5
2	/ 7
3	/ 4
4	/ 5
5	/ 8
6	/ 4
7	/ 7
Section B (two questions only)	
8	/ 20
9	/ 20
10	/ 20
Total Marks	/ 80

For Examiner's Use

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-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
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	=	$\rho g h$
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

For Examiner's Use

Section A

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

1 A student wants to determine the density of a solid circular cylinder by measuring its dimensions with a ruler and its weight using a mass balance. He recorded his readings as follows.

Diameter of the circular base = (8.6 ± 0.2) cm
Height of the cylinder = (7.4 ± 0.2) cm
Mass of the cylinder = (449.3 ± 0.1) g

(a) Determine a value for the density of the disc with its associated uncertainty.

density = …… ± ……..…… kg m^{-3} [4]

(b) Explain which variable has the largest impact on the uncertainty of the density.

……..……..……

……..……..……..……..……..…….. [1]

For Examiner's Use

2 **(a)** State the conditions for a body to move in parabolic motion.

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…… [2]

(b) A ball was launched from a 2.0 m cliff with an initial velocity of 5.0 m s^{-1} and at an angle of 30° from the horizontal as shown in Fig. 2.1. Assume that air resistance can be ignored.

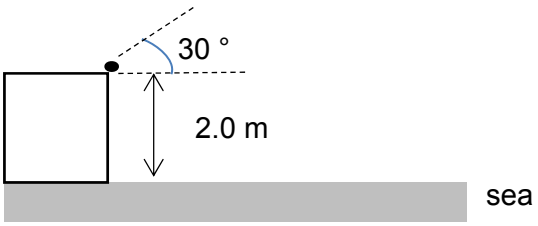

Fig. 2.1

Determine

(i) the maximum height of the ball as measured from sea-level.

maximum height = …… m [2]

(ii) the speed and direction of the ball as it enters the sea.

speed = …… m s^{-1}

direction = …….. [3]

For Examiner's Use

3 Box **A** rests on a smooth slope and is connected to box **B** with a light inextensible string as shown in Fig. 3.1. Box **A** and box **B** have masses of 10 kg and 3 kg respectively. The setup is initially at rest.

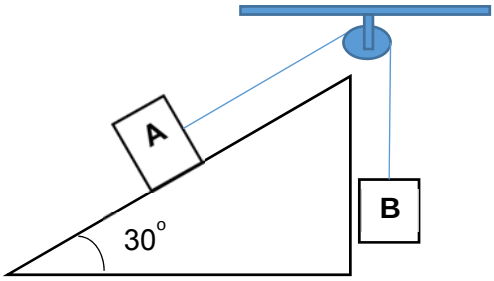

Fig. 3.1

(a) Determine the acceleration of Box **A** when the boxes move.

acceleration = …… m s^{-2} [2]

(b) In practice, the acceleration is lower than your answer in part **(a)**. Suggest two reasons to account for this.

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…… [2]

For Examiner's Use

4 **(a)** Define *work*.

……..…

……. [1]

(b) In each of the following situations, describe how work is done on the object and the energy changes.

(i) A small and heavy ball released from rest in the school laboratory.

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…….. [2]

(ii) A bicycle coming to a stop at the traffic light.

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…….. [2]

For Examiner's Use

5 **(a)** Define the *ohm*.

……..……..……

……..……..……..……..…… [1]

(b) A circuit is set up as shown in Fig. 5.1. Two identical bulbs, **A** and **B**, are arranged in parallel with a dry cell **P**. The voltmeter reading is 4.0 V.

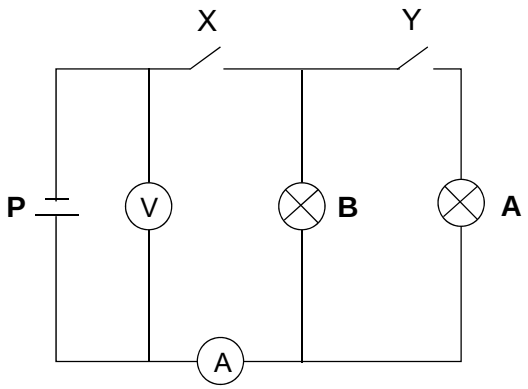

Fig. 5.1

Switch X is now closed. The voltmeter reading dropped to 3.9 V and the ammeter reading is 0.1 A.

(i) Determine the internal resistance of the cell **P**.

internal resistance = …… Ω [2]

(ii) Calculate the power supplied by the cell **P**.

power = …… W [1]

For Examiner's Use

(iii) Switch Y is now closed.

Without calculation, explain the changes to

the voltmeter reading,
the ammeter reading,
the brightness of bulbs **A** and **B**,
and the power supplied by the cell **P**.

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…… [4]

For Examiner's Use

6 **(a)** Define the *tesla*.

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……..... [1]

(b) Fig. 6.1 shows one section of a long straight wire carrying a steady current to the right.

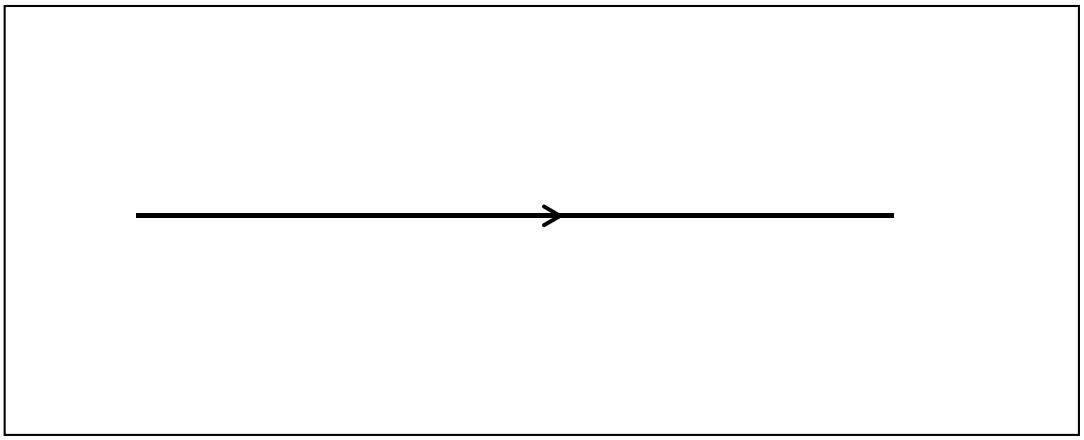

Fig. 6.1

Using crosses (×) and dots (•) to indicate the directions of the magnetic flux density, draw within the box on Fig. 6.1, the magnetic field around the wire. [2]

(c) The wire in part **(b)** is now placed within an external uniform magnetic field as shown in Fig. 6.2.

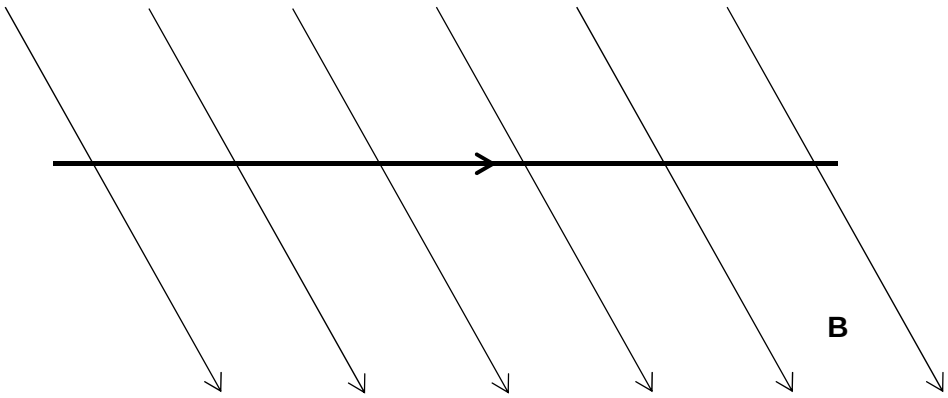

Fig. 6.2

State the direction of the magnetic force acting on the wire.

…… [1]

For Examiner's Use

7 A force is applied on an extension spring. The variation with extension of the elastic potential energy of the spring is shown in Fig. 7.1.

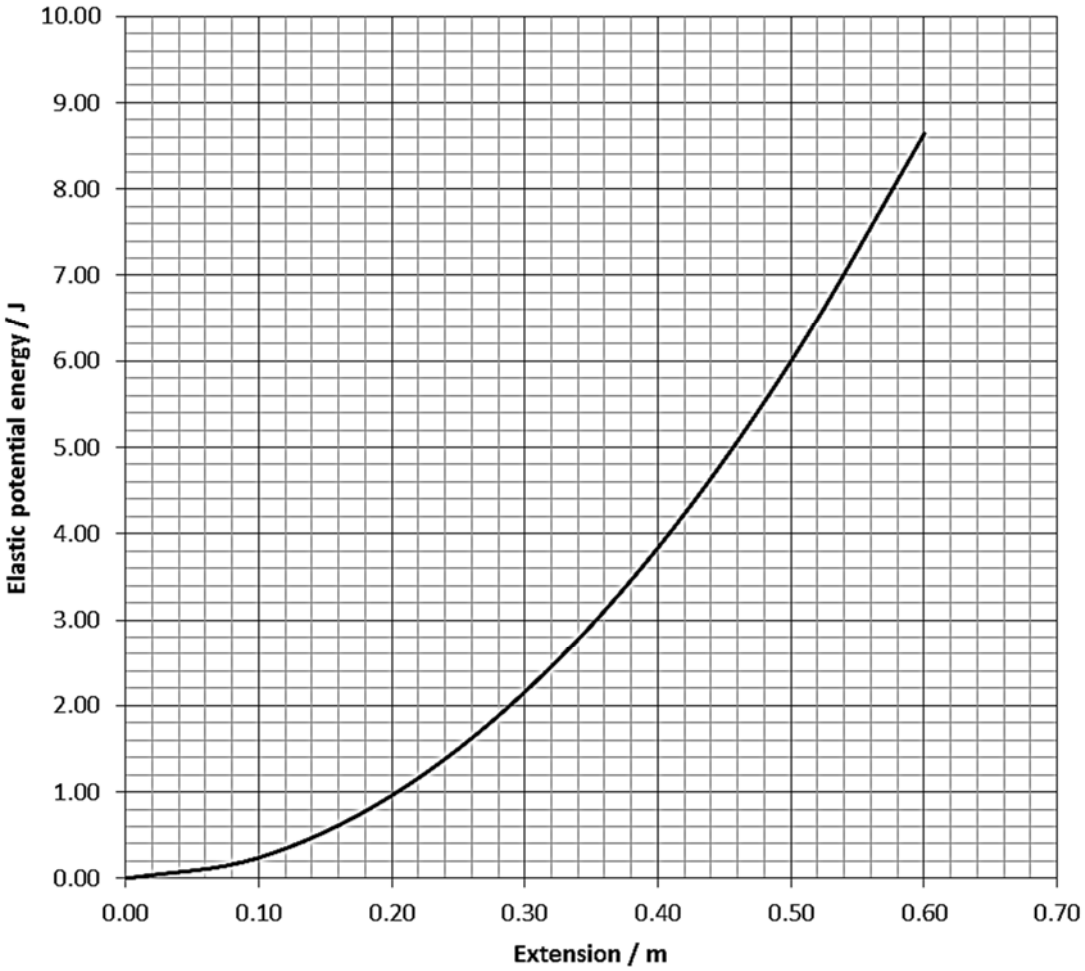

Fig.7.1

(a) Suggest how you would determine the magnitude of the spring force from Fig. 7.1.

……..

……. [1]

For Examiner's Use

(b) The elastic potential energy of the spring is directly proportional to the square of its extension.

Using Fig. 7.1, show that this relationship is valid.

[4]

(c) Using your answer to part **(b)** or otherwise, state the value of the spring constant.

…… [1]

(d) State the condition of the spring for the graph in Fig. 7.1 to be valid.

…… [1]

For Examiner's Use

Section B

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

8 (a) (i) Explain what is meant by *impulse*.

……

…… [1]

(ii) State Newton's second law of motion.

……

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…… [2]

(b) Using your answers in **(a)**, explain,

(i) why it is safer for a driver to wear a seat belt than not wearing a seat belt.

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…… [2]

(ii) why it is better for a soccer player to not slow down his leg at the end of a kick.

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…… [2]

(c) Fig. 8.1(a) shows a sphere A of mass m_A and velocity $\overrightarrow{u_A}$, and a sphere B of mass m_B and velocity $\overrightarrow{u_B}$.

Fig. 8.1(b) shows the same spheres at velocities $\overrightarrow{v_A}$ and $\overrightarrow{v_B}$ after a head-on collision.

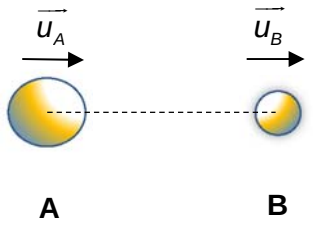


Fig. 8.1(a)

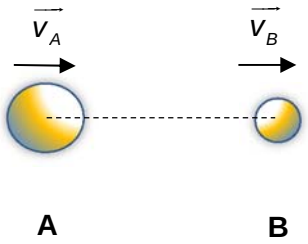


Fig. 8.1(b)

(i) Using Newton's laws of motion, show that

$$m_A\overrightarrow{u_A} + m_B\overrightarrow{u_B} = m_A\overrightarrow{v_A} + m_B\overrightarrow{v_B}$$

[2]

(ii) State the condition for the equation in part **(c)(i)** to be true.

……

…… [1]

For Examiner's Use

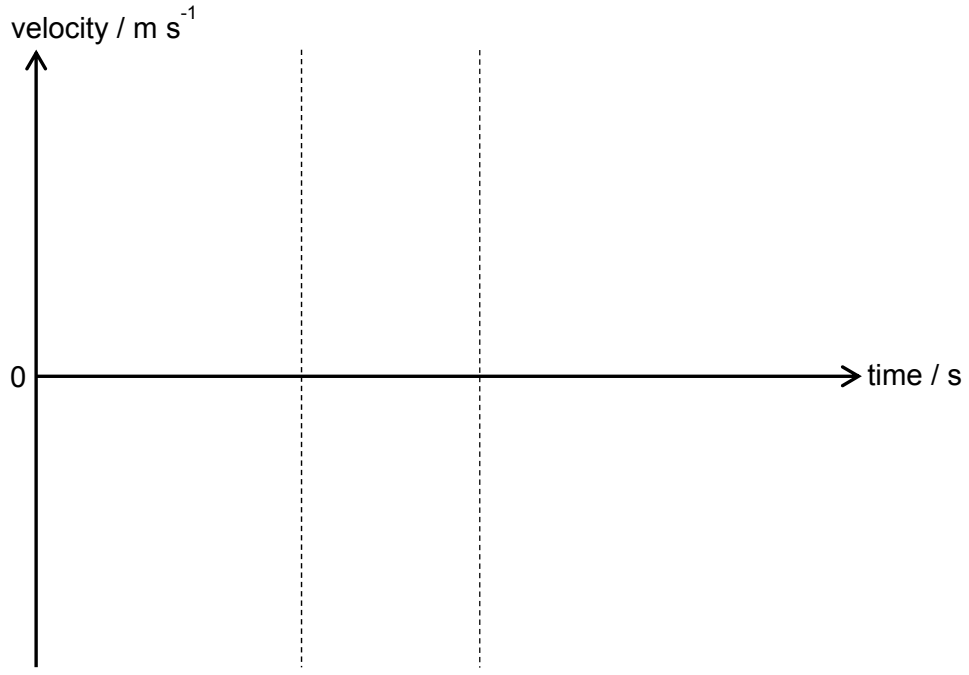
(iii) Given that m_A = 3.0 kg, m_B = 1.0 kg, $\overrightarrow{u_A}$ = +2.0 m s^{-1}, and $\overrightarrow{u_B}$ = - 2.0 m s^{-1}, complete the table. Show all workings clearly.

	before collision		***after*** collision	
	A	**B**	**A**	**B**
kinetic energy / J	**6.0**	**2.0**	**0**	**8.0**
momentum / N s	**6.0**			

Space for working:

[3]

(iv) Hence, sketch the variation with time of the velocities of **A** and **B**, before, during and after the collision. Label the graphs clearly.



[3]

For Examiner's Use

(d) A student stands on a weighing scale in the lift and notices that the reading on the weighing scale fluctuates as the lift ascends from the first to the fifth floor.

By drawing a suitable free-body diagram and applying Newton's second law of motion, explain,

(i) why the reading increases as the lift starts to ascend from the first floor.

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..…….. [2]

(ii) why the reading decreases as the lift is reaching the fifth floor.

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..…….. [2]

For Examiner's Use

9 **(a)** State the Principle of Superposition.

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…… [2]

(b) Using a graphical method, explain the formation of stationary waves on a stretched string.

[5]

For Examiner's Use

(c) A contractor tries to measure the depth of a new well shaft so that he can build a ladder to reach the bottom of the shaft. He uses a speaker with adjustable frequency and positions it at the top of the well. Two successive resonances are heard at 77.5 Hz and 98.5 Hz. The speed of sound is 343 m s^{-1}.

Determine the depth of the well.

depth of well = …… m [3]

(d) (i) Explain why transverse waves can be polarised but not longitudinal waves.

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…… [2]

For Examiner's Use

(ii) A beam of unpolarised light is passing through two Polaroid filters as shown in Fig. 9.1. The transmitting axes of these filters are intially aligned.

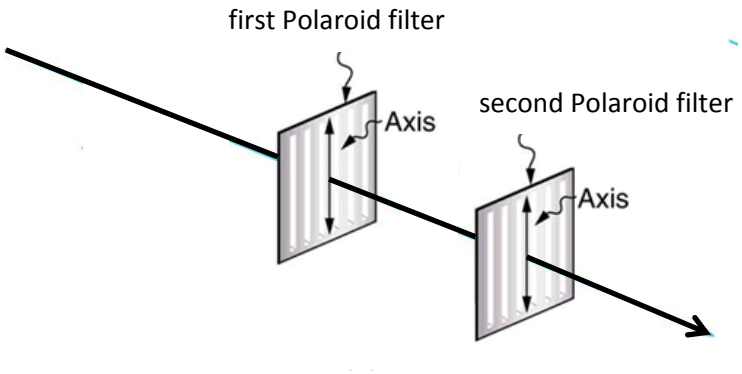

Fig. 9.1.

The intensity of the light emerging from the first filter is I.

1. State the intensity of the light before entering the first filter in terms of I.

…… [1]

2. The second filter is now rotated through 360° in its own plane.

State and explain the number of maxima of intensity that occur in the light emerging from the second filter after it starts to rotate.

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…… [3]

For Examiner's Use

(e) A point source produces a wave that spreads out in all direction. At a distance of 1.5 m from the source, the amplitude of the wave is 2.3 mm.

(i) State the relationship between the intensity of the wave I and the distance from the point source d.

…… [1]

(ii) Hence, or otherwise, determine the amplitude of the wave at a distance of 2.5 m from the source.

amplitude = …… mm [3]

For Examiner's Use

10 (a) The element composition of gas clouds in space can be determined by observing the spectrum of light detected when we point our telescopes at them.

The type of spectrum depends on how the electromagnetic radiation reaches the telescopes as shown in Fig. 10.1.

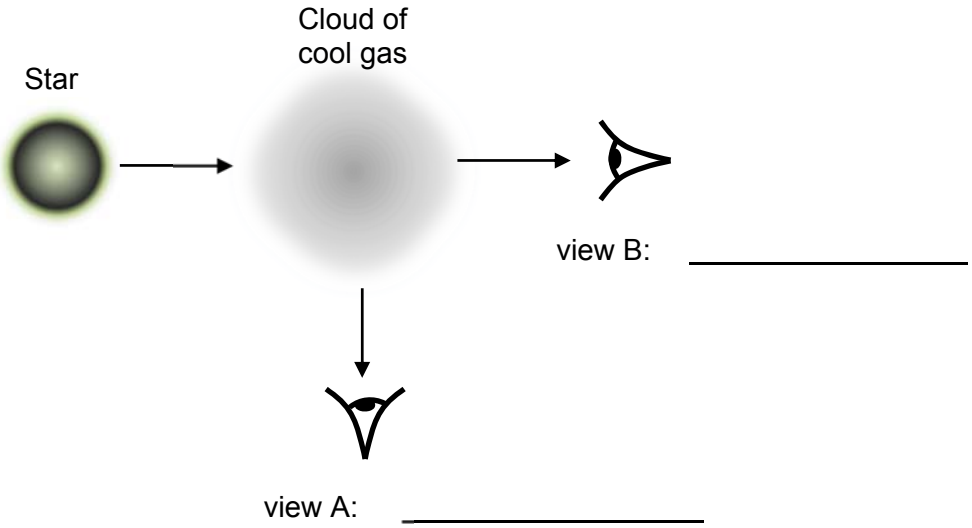

Fig. 10.1

(i) Label, on Fig. 10.1, the two different types of spectrum that can be observed from view A and B. [1]

For Examiner's Use

(ii) Fig. 10.2 shows a spectrum from Orion nebula, a gas cloud in the constellation Orion. The spectrum contains a combination of spectral lines from different elements, which provides evidence that this gas cloud contains many different elements.

The spectral lines are labelled using the atomic symbol for that particular element (e.g. H, He, etc) with their corresponding wavelengths. In particular, hydrogen lines of different wavelengths have notations using the Greek alphabet (e.g. Hα).

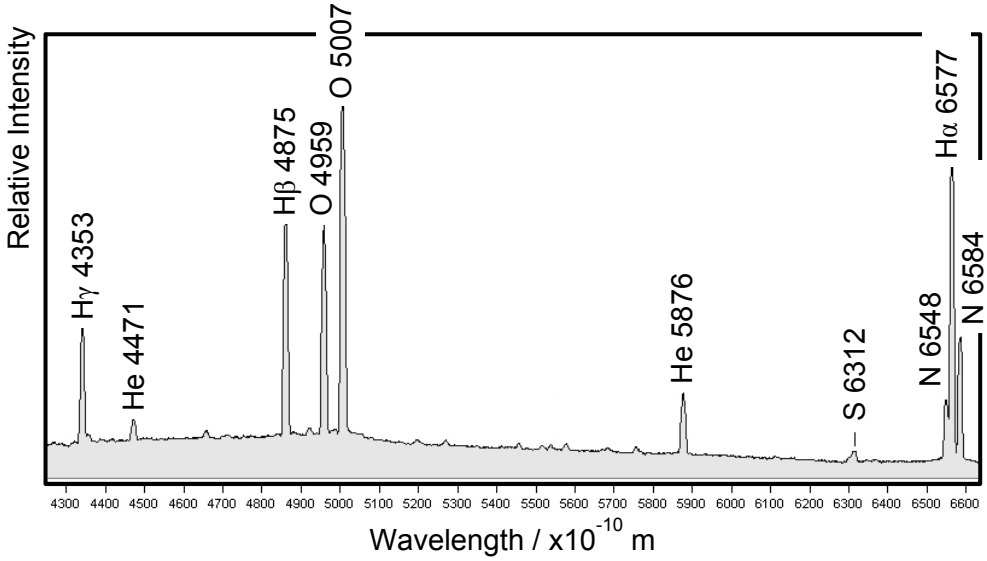

Fig. 10.2

1. State and explain whether this spectrum is recorded from view A or B.

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…… [2]

2. Suggest why the relative intensity of hydrogen spectra lines are higher than that of helium.

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…… [1]

For Examiner's Use

3. Fig. 10.3 shows the lowest six energy levels of the hydrogen atom. Each of the hydrogen spectral line in Fig. 10.2 corresponds to a transition between the energy levels of hydrogen. The transition for Hα line is shown in Fig. 10.3.

Draw and label the energy transitions, Hβ and Hγ, which are responsible for producing the spectral lines of hydrogen in Fig. 10.2. Show your working clearly.

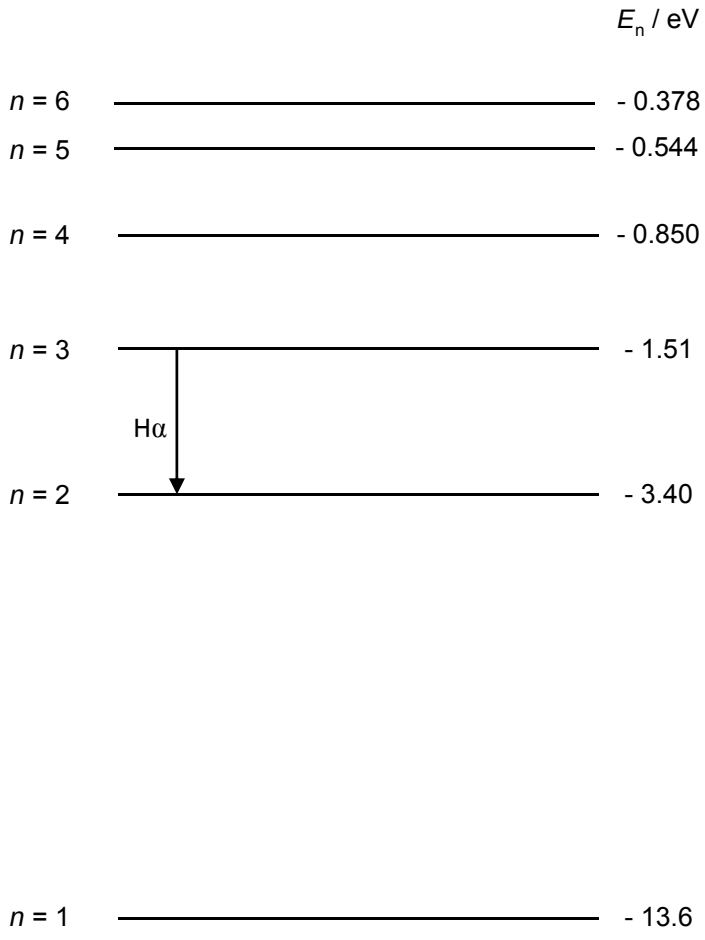

Fig. 10.3

Space for working:

[3]

For Examiner's Use

(b) Electromagnetic radiation can exhibit wave or particle properties in different circumstances.

(i) The photoelectric effect experiment shows that electromagnetic radiation has a particulate nature.

Describe and explain two observations from the photoelectric effect experiment that give evidences for the particulate nature of electromagnetic radiation and not its wave nature.

1.

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…… [2]

2.

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…… [2]

For Examiner's Use

(ii) The wave nature of light can be supported by other experimental evidence.

Describe, with the aid of a diagram, an experiment which provides evidence for the wave nature of electromagnetic radiation.

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………………………………………………………………………………………. [4]

For Examiner's Use

(c) Protons, similar to electromagnetic radiation, can also exhibit wave or particle properties depending on the situation.

Protons are accelerated from rest across a potential difference of 500 kV.

(i) Determine the de Broglie wavelength of the protons after they have obtained their maximum speed.

wavelength = …….. m [3]

(ii) State and explain whether the accelerated protons in part **(c)(i)** can be used to demonstrate proton diffraction.

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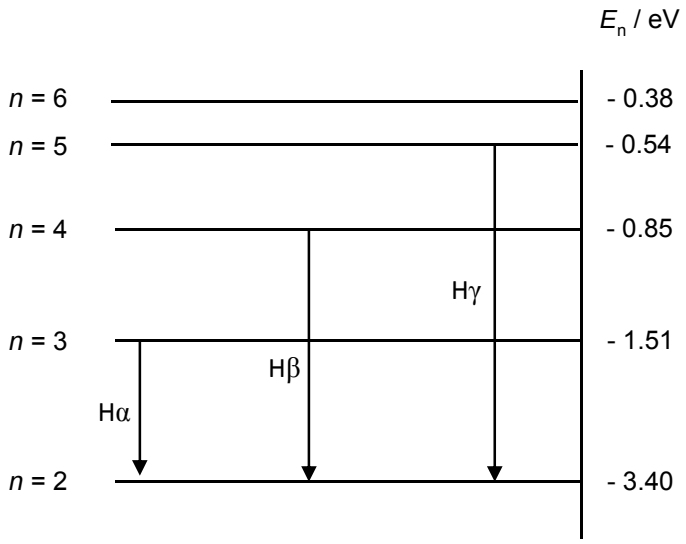
…… [2]

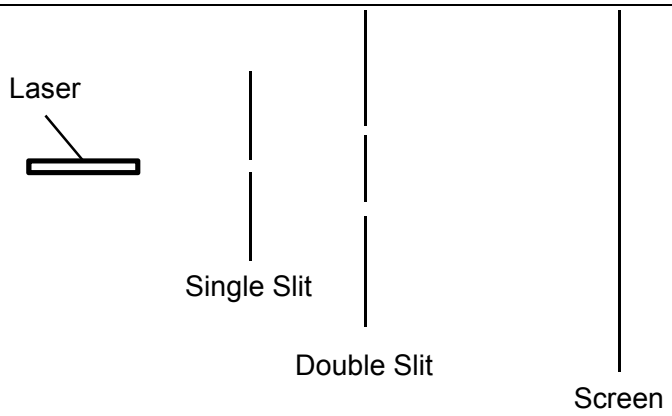
Qn	MS
1a	$\rho = \dfrac{\text{mass}}{\text{volume}}$ $= \dfrac{0.4493}{\pi(\frac{0.086}{2})^2(0.074)}$ $= 1.0451\times10^3$ kg m^{-3}
	$\rho = \dfrac{\text{m}}{\text{v}}$ $= \dfrac{\text{m}}{\pi(\frac{\text{d}}{2})^2 h}$ $\pm\dfrac{\Delta\rho}{\rho} = \pm(\dfrac{\Delta m}{m} + 2\dfrac{\Delta d}{d} + \dfrac{\Delta h}{h})$
	$= \pm(\dfrac{0.1}{449.3}) + 2(\dfrac{0.2}{8.6}) + (\dfrac{0.2}{7.4})$ $= \pm 0.0738$
	$\pm\Delta\rho = \pm 77$ $\approx \pm 80$ kg m^{-3} $\therefore \rho \pm \Delta\rho = (1.04 \pm 0.08)\times10^3$ kg m^{-3}
b	Diameter as the term $2\dfrac{\Delta d}{d}$ has the largest contribution to the uncertainty of density.
2a	Constant velocity in horizontal direction
	Constant acceleration in vertical direction
b (i)	$v_y^{\,2} = u_y^{\,2} + 2a_y s_y$ $0 = (5\sin 30°)^2 + 2(-9.81)(s_y)$ $s_y = 0.319m$
	$Height = 2 + 0.319 = 2.319m$
(ii)	$v_y^{\,2} = u_y^{\,2} + 2a_y s_y$ $v_y^{\,2} = 0 + 2(-9.81)(2.319)$ $v_y = 6.75ms^{-1}$
	$v = \sqrt{(5\cos 30°)^2 + (6.75)^2}$ $v = 8.02ms^{-1}$
	$\tan\theta = \dfrac{6.75}{5\cos 30°}$ $\theta = 57.3°$ below the horizontal

3a	$T - m_B g = m_B a$
	$m_A g \sin 30° - T = m_B a$
	$a = \dfrac{m_A g \sin 30° - m_B g}{m_B + m_A}$ $= 1.51 ms^{-2}$
b	Friction at axle of pulley
	Slope has friction
	Accept air resistance
4a	Work done is the product of force on an object and its displacement in the direction of the force.
b(i)	Work done by gravitational force on object is positive
	Loss in GPE becomes Gain in KE
(ii)	Work done by brakes on wheels is negative
	Loss in KE of wheel becomes thermal energy
5a	The ohm is the resistance of a component when a potential difference of 1 volt drives a current of 1 ampere through it
b (i)	E = V + Ir $emf - Ir = 3.9$ $(0.1)r = 4 - 3.9$ $r = 1.0\Omega$
(ii)	$P = VI$ $= (4)(0.1)$ $= 0.4W$
(iii)	Total resistance of the circuit decreases, ammeter reading increases
	As Ir increase, voltmeter reading decreases
	As the pd drop across the bulbs decreases, brightness of bulbs decrease
	As the current drawn is larger, power supplied by cell increases
6a	Tesla is the magnetic flux density when a wire carrying a current of 1 A placed at right angles to the magnetic field experiences a force of 1 N per metre
b	equally spaced crosses and dots
	spacing of crosses and dots wider at farther distance from wire
c	into the paper
7a	Gradient of the tangent of graph

b	Know that U α x^2
	Calculate first set of Ux^2
	Calculate second set of Ux^2
	Suitable conclusion
c	K = 50 (actual value = 48)
d	Spring must obey Hooke's Law
8a(i)	Product of force and time
(ii)	Rate of change of momentum of a body is directly proportional to the net external force acting on the body
	Direction of change of momentum is same as direction of net force
b(i)	Change in momentum is the same for both cases
	Seat belt: time is longer hence force on passenger is lower
(ii)	Longer time of kick means larger impulse
	Ball travels faster
c(i)	N2L: F b on a = (mva – mua) / t
	F a on b = (mvb – mub) / t
	N3L: F a on b = - F b on a
	Substitute equation and rearrange
(ii)	No net external force acts on system
(iii)	Pa = 0
	mbub = (1)(-2.0)
	Pb after collision = 4
(iv)	Graph correct before collision
	During collision
	After collision
(d)(i)	FBD correct
	N – W = ma
(ii)	FBD correct
	W – N = ma

9(a)	When two or more progressive waves meet
	The resultant displacement of the wave is the vector sum of the displacement of individual wave
(b)	Two progressive waves with same amplitude and frequency and speed and travelling in opposite direction
	Appropriate graphs
	Node – zero displacement/points of destructive interference
	Antinode – max amplitude/points of constructive interference
(c)	90.8 – 70.6 = 2
	343 = (fundamental freq)(λ)
	L = 2λ
(d)(i)	Transverse waves have vibrations which are perpendicular to direction of energy transfer therefore oscillation can be restricted to a single directin
	Longitudinal waves have vibrations which are parallel to energy transfer
(ii)1.	2I
2.	Maxima when axes are aligned OR explain variation in intensity
	$I = I_o\cos^2\theta$
	2
(e)(i)	Intensity is inversely proportional to square of distance from point source
(ii)	$I \alpha A^2$
	$A \alpha 1/d$
	2.3/A = 2.5/1.5
	A = 1.38 mm
10a (i)	A – Emission spectrum B – Absorption spectrum
(ii) 1.	Higher intensity for spectrum lines while all other wavelengths are fairly constant and low
	A – emission spectrum
	Image from http://www.lafterhall.com/Special_Interest_Spectroscopy.html
(ii) 2.	Hydrogen is in larger concentration in the gas cloud than Helium

(ii) 3.	Energy of $H_\beta = \dfrac{hc}{\lambda_\beta} = \dfrac{6.63\times10^{-34}\times3\times10^{8}}{4862\times10^{-10}}$ $\left(=4.09\times10^{-19}\ \text{J}\right)$ $=2.55\ \text{eV}$
	Energy of $H_\gamma = \dfrac{hc}{\lambda_\gamma} = \dfrac{6.63\times10^{-34}\times3\times10^{8}}{4340\times10^{-10}}$ $\left(=4.58\times10^{-19}\ \text{J}\right)$ $=2.864\ \text{eV}$
	 Correct label. Ignore arrow direction.
(b)(i)	Any of the following 2 pair of answers: When light below (above) a threshold frequency (wavelength) shines on the metal, there is no current flowing through the circuit.
	Since particles of light carry discrete packets of energy, each photon must carry sufficient energy, hf_0, in order to knock out the surface electrons.
	Current flows almost instantaneously after light is shone on the metal.
	Photons are packets of energy and will instantaneously transfer all of its energy to the electron.
	Maximum KE o electrons/Stopping potential is not affected by a change in intensity of light.
	Increasing/Decreasing the intensity on increases the number of photons hitting the metal surface per unit time. Each photon still imparts the same energy to each electron no matter how high the intensity.

(ii)	 Appropriate Diagram drawn: - Coherent source - Double slit and screen
	Describe how two coherent EM source can be set up to observe their interference pattern.
	Explain that in this experiment, light can diffract into its geometric shadow (at the single slit, and) at both of the double slit. This highlights one wave like property.
	Explain that interference patterns of bright and dark bands will be formed at the screen, which is a result of superposition of the EM waves coming from both slits (sources). Superposition is a wave property.
(c)(i)	$\text{gain in KE} = \text{ lost in Electric PE} = eV_s = \left(1.60\times10^{-19}\right)\left(500\times10^{3}\right)$ $\left(=8.0\times10^{-14}\ \text{J}\right)$
	$p=\sqrt{2(1.67\times10^{-27})(8.0\times10^{-14})}$ = 1.635x10^{-20} kg m s^{-1}
	$\lambda=\frac{h}{p}=\frac{6.63\times10^{-34}}{1.635\times10^{-20}}$ = 4.06 x 10^{-14}
(ii)	De Broglie wavelength is too small and not of the order of the spacing between atoms (~10^{-10}m)
	Hence, no diffraction pattern is observable.