EUNOIA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS 2018
General Certificate of Education Advanced Level
Higher 1

PHYSICS

8867/01

Paper 1 Multiple Choice

20 September 2018

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use paper clips, glue or correction fluid.
Write your name, civics group and registration number on the Answer Sheet in the spaces 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 booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **16** printed pages and **0** blank page.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
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
the Avogadro constant,	N_A	=	6.02×10^{23} mol^{-1}
gravitational constant,	G	=	6.67×10^{-11} N m^{2} kg^{-2}
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion,	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

1 What is a good estimate of the density of a $1 Singapore coin?

A 8.0×10^{-1} g mm^{-3}

B 8.0×10^{-2} g mm^{-3}

C 8.0×10^{-3} g mm^{-3}

D 8.0×10^{-4} g mm^{-3}

2 Measurements are subjected to both systematic error and random error.

Which measurements have high accuracy and low precision?

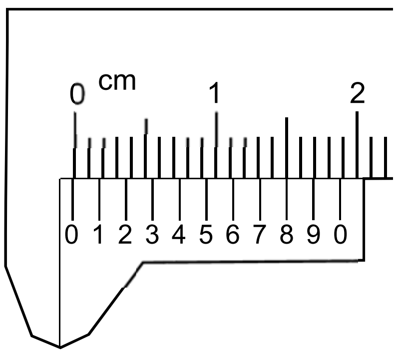
A High random error and high systematic error

B High random error and low systematic error

C Low random error and high systematic error

D Low random error and low systematic error

3 The diagram shows the zero reading of a vernier calliper.



Which of the following statements about subsequent readings taken by the vernier calliper is/are true?

1 They are subject to random errors.
2 They are subject to a systematic error that is consistently 0.02 cm less.
3 They are subject to a systematic error that is consistently 0.08 cm less.
4 They are subject to a systematic error that is consistently 0.08 cm more.

A 1 and 2

B 1 and 3

C 1 and 4

D 4 only

4 A boy dropped a spherical ball from rest within a fluid.

Which of the following statements is true for the motion of the spherical ball?

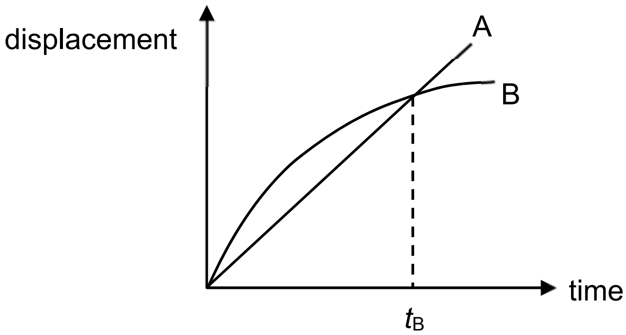
A Its velocity decreases as distance fallen increases.

B Its velocity remains constant.

C Its kinetic energy increases uniformly with distance.

D Its acceleration decreases as the distance fallen increases.

5 The diagram below shows the variation of displacement with time for 2 trains, Train A and Train B, running on parallel tracks.



Which of the following statements is correct?

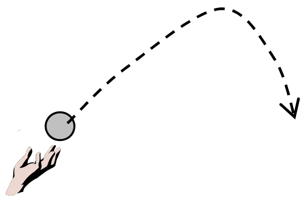
A At time t_B, both trains have the same velocity.

B Both trains speed up all the time.

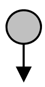
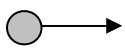
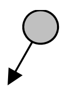
C Both trains have the same velocity at some time before t_B.

D Somewhere on the graph, both trains have the same acceleration.

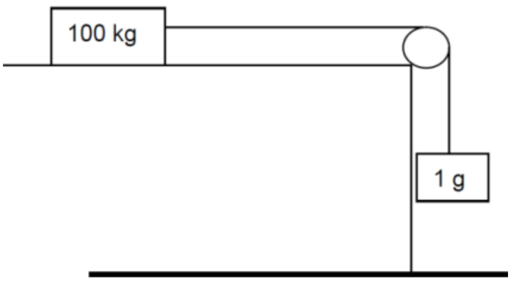
6 A ball thrown at an angle **in air** travels in a trajectory as shown in the diagram below.



When the ball is at the top of its flight, which of the following shows the direction its resultant acceleration?

A  **B**  **C**  **D** 

7 A 100 kg mass, which rests on a frictionless table, is attached to a 1 gram mass through an inextensible string that goes round a smooth pulley.



What is the acceleration of the 100 kg mass?

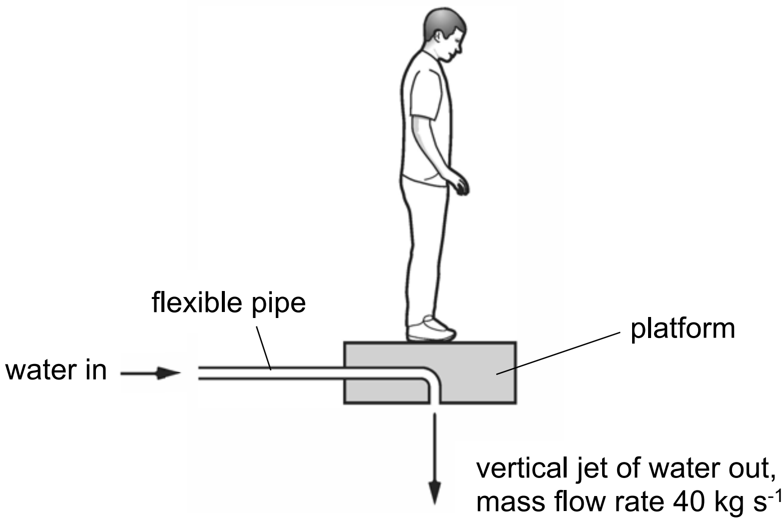
A 9.81×10^{-5} m s^{-1}

B 9.81×10^{-2} m s^{-2}

C 0 m s^{-2}

D 9.81 m s^{-2}

8 The diagram shows a man standing on a platform that is attached to a flexible pipe. Water is pumped through the pipe so that the man and platform remain at a constant height.



The resultant vertical force on the platform is zero. The combined mass of the man and platform is 96 kg. The mass of water that is discharged vertically downwards from the platform each second is 40 kg.

What is the speed of the water leaving the platform?

A 2.4 m s^{-1}

B 6.9 m s^{-1}

C 24 m s^{-1}

D 47 m s^{-1}

9 Two objects A and B collide head-on on a horizontal, frictionless surface. The velocities of the objects before the collision and after the collision are shown in the diagram below.

Which of the following statements is correct?

A The sum of the kinetic energies of A and B is conserved.

B The collision is possibly inelastic.

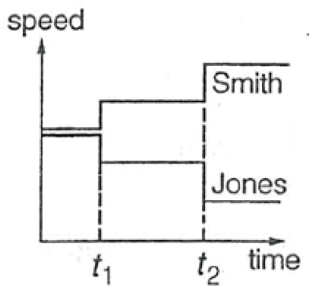
C The total momentum of the two objects cannot be conserved since no net external force acts on them.

D The momentum of each object is conserved.

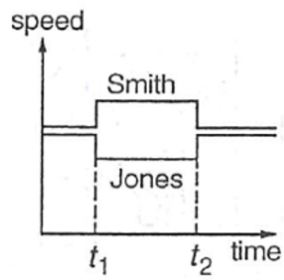
10 Smith and Jones are skating on ice (assumed frictionless) so that they are moving at equal speeds s in the same straight line. Smith is skating backwards facing Jones. Smith throws a ball at Jones at time t_1 and receives it back at time t_2.

Assuming the time of flight of the ball is negligible, which of the diagrams below correctly show variation of speed with time for the two skaters?

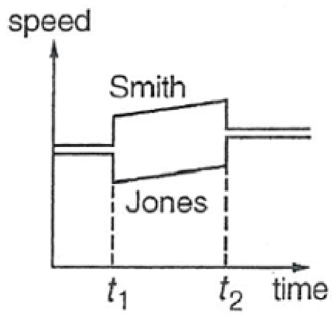
A



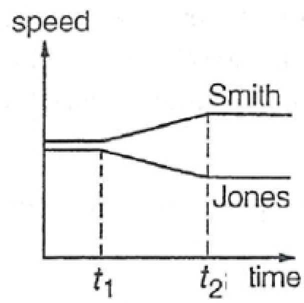
B



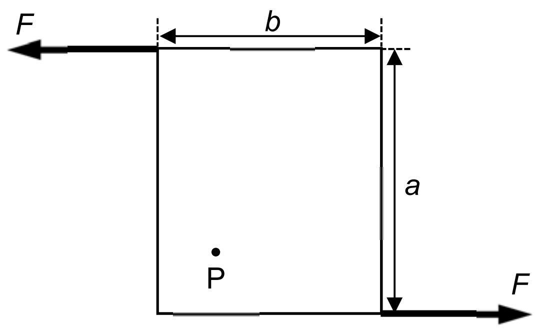
C



D



11 Two forces, each of magnitude *F*, act along the edges of a rectangular metal plate, as shown.



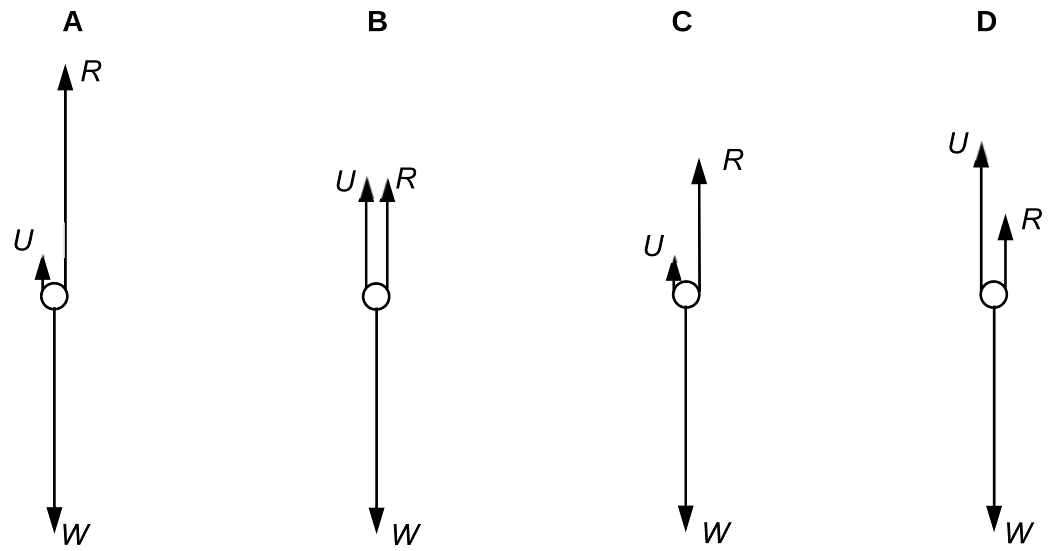
The plate has length *a* and width *b*.

What is the torque about point P?

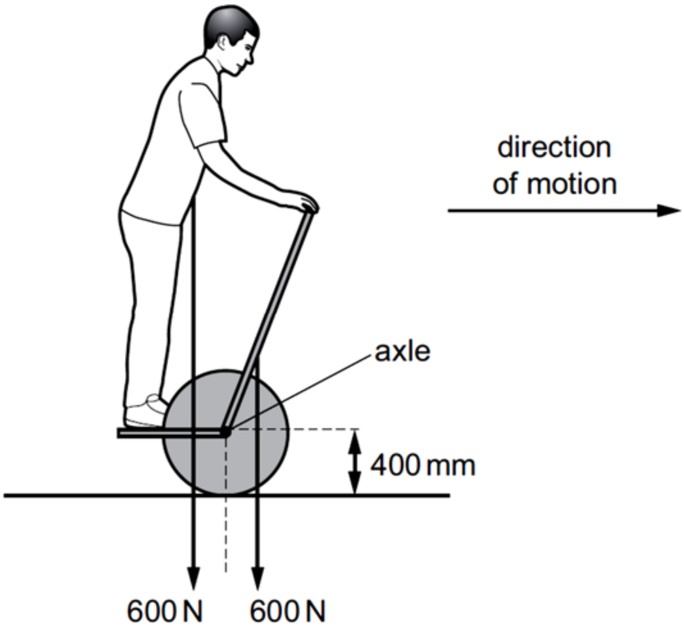
A *Fa* **B** *Fb* **C** *2Fa* **D** *2Fb*

12 A spherical water droplet is falling through air at its terminal velocity. Three forces act on it, its weight *W*, upthrust *U* and air resistance *R*.

Which diagram, showing these three forces to scale, is correct?



13 The diagram below shows a motorised vehicle for carrying one person.



The vehicle has two wheels on one axle. The passenger stands on a platform between the wheels.

The weight of the machine is 600 N. Its centre of mass is 200 mm in front of the axle. The wheel radius is 400 mm.

When stationary, a passenger of weight 600 N stands with his centre of mass 200 mm behind the axle to balance the machine.

The motor is now switched on to provide a horizontal force of 90 N at the ground to move the vehicle forwards.

How far and in which direction must the passenger move his centre of mass to maintain balance?

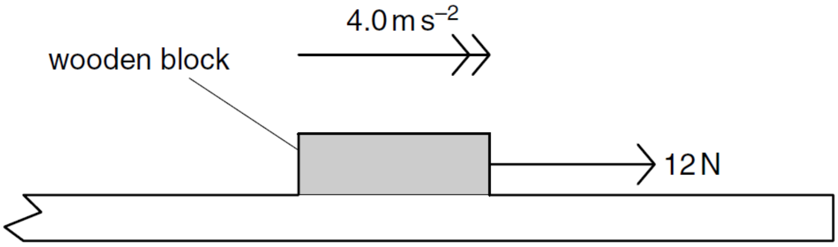
A 60 mm backward

B 60 mm forward

C 140 mm backward

D 140 mm forward

14 A wooden block of mass 1.0 kg is on a rough horizontal surface. A force of 12 N is applied to the block and it accelerates at 4.0 m s^{-2}.



What is percentage of work done is used to overcome frictional force when the block is being moved a distance of 10 m?

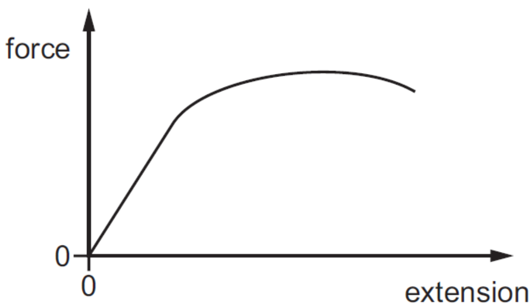
A 33.3% **B** 66.7% **C** 75.0% **D** 100%

15 An area of land is an average of 2.0 m below the sea level. To prevent flooding, pumps are used to lift rainwater up to sea level.

What is the minimum pump output power required to deal with 1.3×10^9 kg of rain per day?

A 15 kW **B** 30 kW **C** 150 kW **D** 300 kW

16 A metal wire is stretched by a load. The force-extension graph is shown.



What is represented by the area under the whole graph?

A the change in gravitational potential energy of the wire

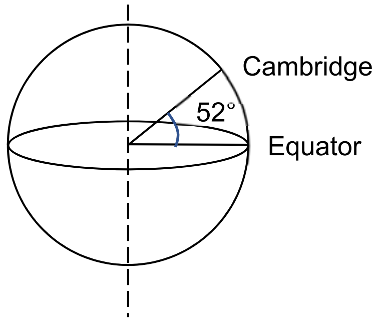
B the energy that would be released from the wire if the final load was removed

C the energy transferred into heat energy in the wire

D the work done in stretching the wire

17 Singapore is on the Equator. Cambridge is at a latitude of 52° N, as shown in the diagram.

A student at Singapore has a centripetal acceleration a_s because of Earth's rotation about its axis. The centripetal acceleration of another student at Cambridge is a_c.

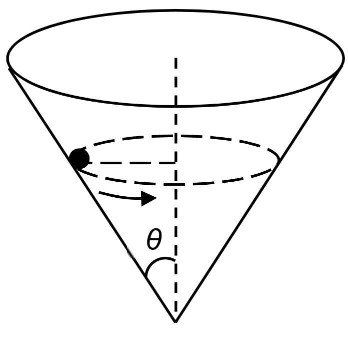


The radius of the Earth = 6.4×10^6 m.
The angular velocity of Earth about its axis = 7.3×10^{-5} rad s^{-1}.

What are the magnitudes of the centripetal acceleration?

	a_s / m s^{-2}	a_c / m s^{-2}
A	3.4×10^{-2}	2.1×10^{-2}
B	3.4×10^{-2}	2.7×10^{-2}
C	3.4×10^{-2}	3.4×10^{-2}
D	4.7×10^{-2}	4.7×10^{-2}

18 A small bead is set into circular motion in a horizontal plane within a smooth conical cone as shown below.



If the bead is moving with a centripetal acceleration of g, what is the angle θ?

A 30° **B** 45° **C** 55° **D** 70°

19 Two identical particles P and Q are set to travel in a circular path of the same radius. P moves in a vertical and Q moves in a horizontal circle. Both move with the same uniform speed.

Which one of the following statements concerning the magnitude of the net force acting on P and Q towards the center of the respective circular path is correct?

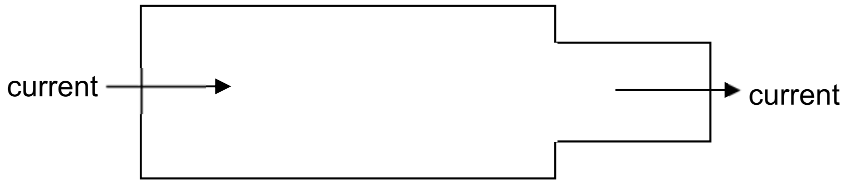
A The net forces on P and Q are always equal in magnitude.

B Both the net forces on P and Q vary with time and are never equal in magnitude.

C Both the net forces on P and Q vary with time and are equal in magnitude periodically.

D The magnitude of the net force on P is always larger than that on Q.

20 The diagram below shows the top view of a conducting strip of uniform thickness. The width of the narrow section is half the width of the wider section.



Which of the following deductions is valid?

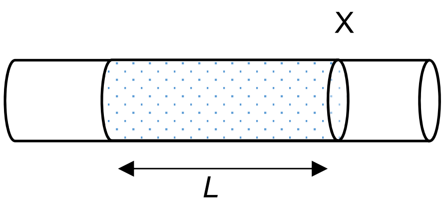
A The resistivity of the narrow section is greater than that of the wide section.

B The current in the narrow section is less than that in the wide section.

C The resistance of the narrow section is more than that of the wide section.

D The resistance per unit length of the narrow section is twice that of the wide section.

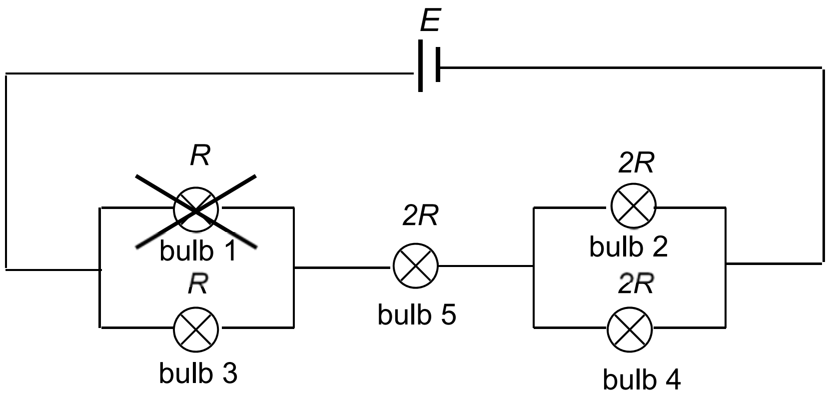
21 A copper wire has a number density of 8.5×10^{28} conduction electrons per cubic metre, and an cross-sectional area of 3.2×10^{-7} m^2. When a potential difference is applied to the ends of the wire, the current is 1.0 A.



If all the electrons within a cylinder of length L pass point X in 60 s, what is the value of L?

A 0.00015 m **B** 0.014 m **C** 0.025 m **D** 0.20 m

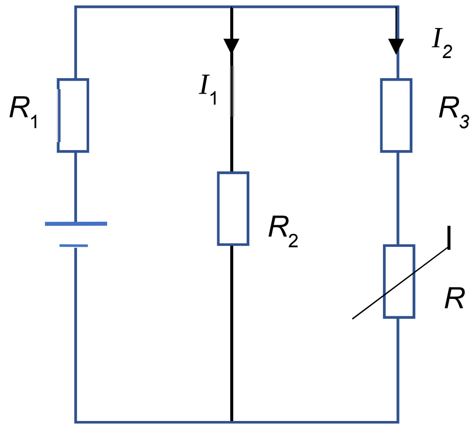
22 Five light bulbs with different resistances as indicated in terms of R in the diagram below are connected to a constant voltage d.c. supply, E, as shown below.



If bulb 1 blows, how will the brightness of the remaining bulbs change?

	bulb 2	bulb 3	bulb 4	bulb 5
A	decreases	increases	decreases	decreases
B	increases	decreases	increases	decreases
C	decreases	decreases	decreases	decreases
D	decreases	increases	decreases	increases

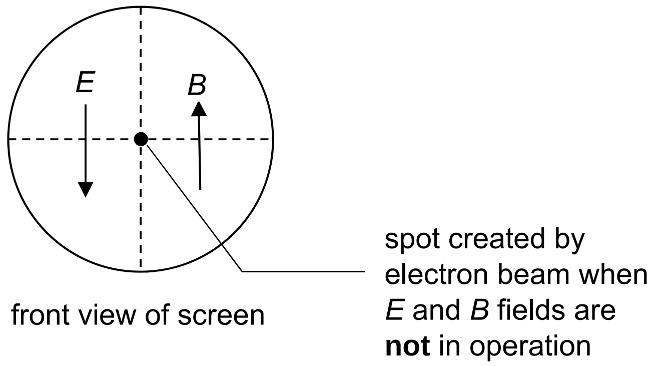
23 In the circuit below, R_1, R_2 and R_3 are fixed resistors and R is a thermistor.



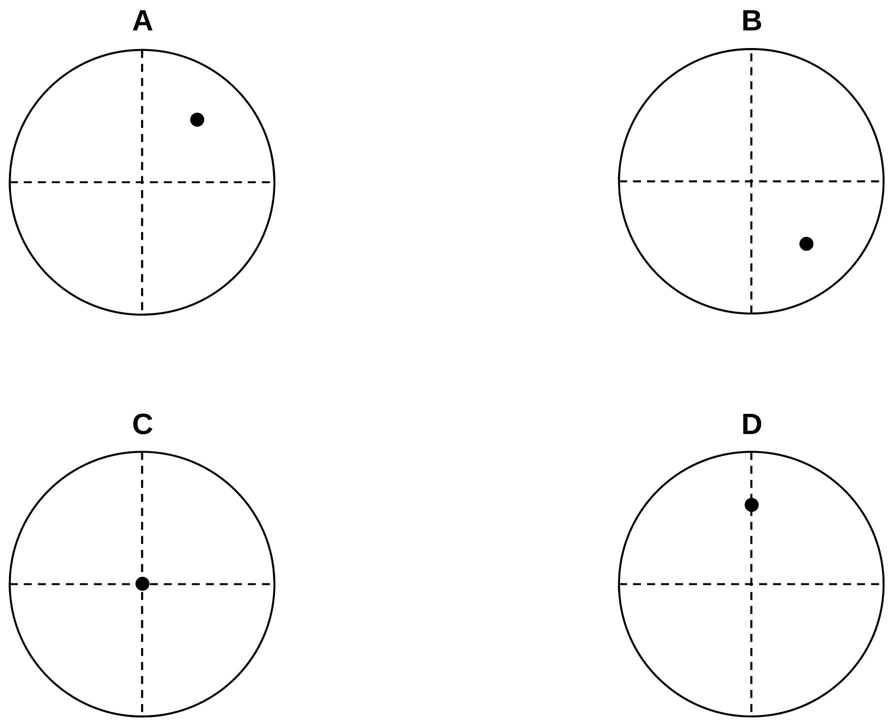
The temperature of the thermistor increases. How will currents I_1 and I_2 change?

	I_1	I_2
A	unchanged	increases
B	decreases	increases
C	increases	decreases
D	increases	increases

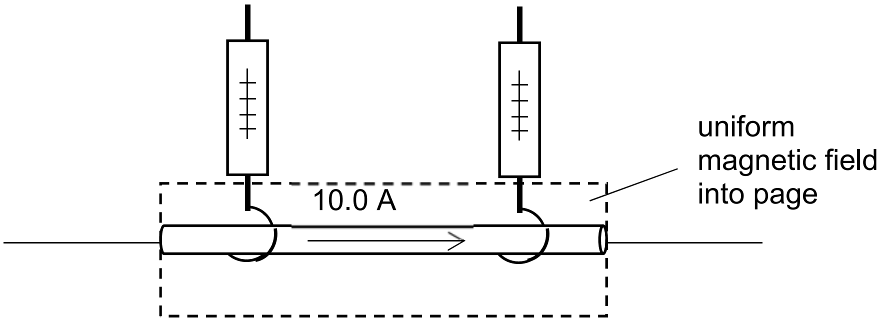
24 In a cathode-ray oscilloscope tube, the electron beam passes through a region where there is an electric field directed vertically downwards and a magnetic field directed vertically upwards as shown in the diagram below.



Which of the diagrams below shows a possible position of the spot on the screen when both fields are operating together?



25 A wire of length 10.0 cm is suspended from two spring balances as shown below.

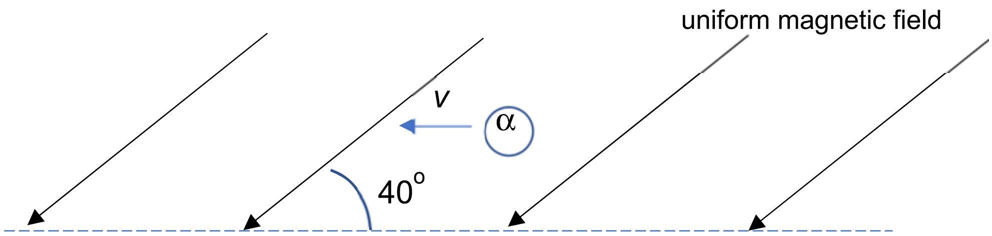


The wire is placed in a region of uniform magnetic field. The magnetic flux is directed perpendicularly into the plane of paper and the magnitude of the flux density is 1.00×10^{-3} T.

When there is no current in the wire, the reading on each spring balance is 10.00 g.
What is the reading on the spring balance when a current of 10.0 A flows through the wire?

A 9.90 g **B** 9.95 g **C** 10.05 g **D** 10.10 g

26 An α-particle with a speed v = 1.5 x10^7 m s^{-1} enters horizontally into a region of uniform magnetic field as shown in diagram below. The magnetic flux density of the magnetic field is 2.5 mT.



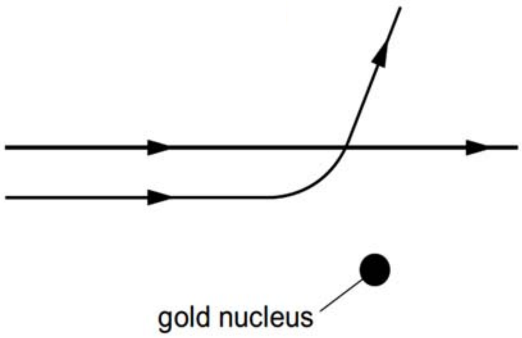
The magnetic force experienced by the α-particle is

	Magnitude	Direction
A	3.4 x10^{-15} N	Perpendicularly out of the page
B	4.6 x10^{-15} N	Perpendicularly into of the page
C	7.7 x10^{-15} N	Perpendicularly out of the page
D	9.2 x10^{-15} N	Perpendicularly into the page

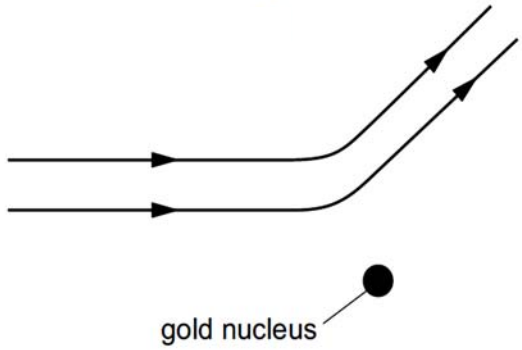
27 Two α-particles with equal energies are fired towards the nucleus of a gold atom.

Which diagram best represents their paths?

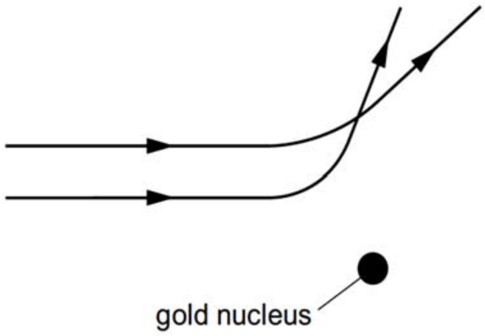
A



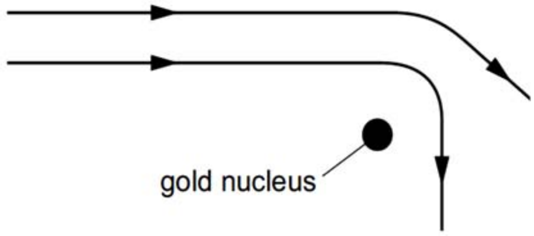
B



C



D



28 Uranium-235 undergoes fission in a reaction shown below, releasing 195 MeV of energy. The binding energy per nucleon for uranium-235 is 7.6 MeV, and those for caesium and rubidium are approximately **X** MeV.

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{143}_{55}Cs + {}^{90}_{37}Rb + 3\,{}^{1}_{0}n$$

What is the value of **X**?

A 6.7 **B** 6.8 **C** 8.4 **D** 8.5

29 Which of the following statements about α-particles is correct?

A α-particles emitted from a single radioactive isotope have a continuous distribution of energies.

B α-particles have less ionising power than β-particles.

C The charge of an α-particle is +1.60 × 10^{-19} C.

D The speeds of α-particles can be as high as 1.5 × 10^{7} m s^{-1}.

30 A radioactive nucleus decays to a daughter nucleus which is an isotope of the original nucleus.

What are the radioactive products emitted?

A one alpha and four beta particles

B four alpha and one beta particles

C two alpha and one beta particles

D one alpha and two beta particles

END OF PAPER

Paper 1 Answer Key

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

EUNOIA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS 2018
General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME					
CIVICS GROUP	1	7	-		

REGISTRATION NUMBER

PHYSICS

8867/02

Paper 2 Structured Questions

14 September 2018

2 hours

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

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

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

Section A
Answer **all** questions.

Section B
Answer any **one** question.

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	
1	
2	
3	
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7	
8	
Total	

This document consists of **26** printed pages and **2** blank pages.

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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** questions in this section

1 **(a)** State Newton's three laws of motion

1. ....

....

.... [1]

2. ....

....

.... [1]

3. ....

....

.... [1]

(b) Use the appropriate laws of motion to answer the following questions:

(i) A passenger claimed that he was sitting in the middle of a bus that was moving forward. The driver suddenly applied the brakes and a suitcase that was in the front of the bus flew backwards and hit him.

State and explain if his claim is valid.

....

....

....

.... [2]

(ii) A labourer was tasked with pulling a cart. He reasoned that whatever he exerts on the cart, the cart will exert an equal and opposite force on him. The forces will cancel out and hence it is pointless for him to pull the cart as both he and the cart will not be able to move.

State and explain if his reasoning is correct.

....

....

....

.... [2]

(iii) A man is stranded in the middle of a frozen lake with a heavy bag of gold. As there is no friction between him and the surface of the ice, he was unable to crawl back to the shore.

State and explain the action that he can take to get back to shore.

…………………………………………………………………………………………...

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…………………………………………………………………………………………...

………………………………………………………………………………………… [2]

(c) **(i)** A small sedan car undergoes a head-on collision with a large truck.

State and explain if the force experienced by the car is different from that experienced by the truck.

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…………………………………………………………………………………………...

………………………………………………………………………………………… [1]

(ii) Both drivers are securely fastened to their vehicle seats. State and explain if the driver of the truck is likely to experience more severe injuries as compared to the driver of the car.

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………………………………………………………………………………………… [2]

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2 **Fig. 2.1** shows an archer with a bow.

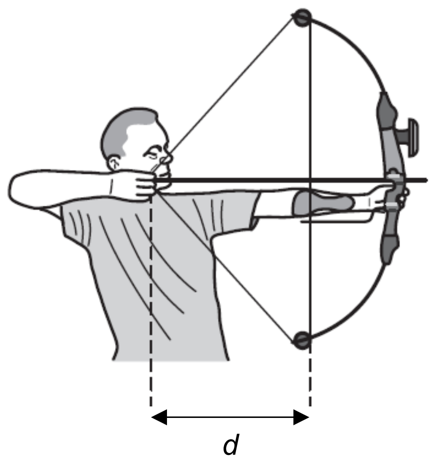

Fig. 2.1

The force *F* required to bend the bow and the corresponding displacement *d* of the arrow are measured. A plot of *F* against *d* is shown in Fig. 2.2.

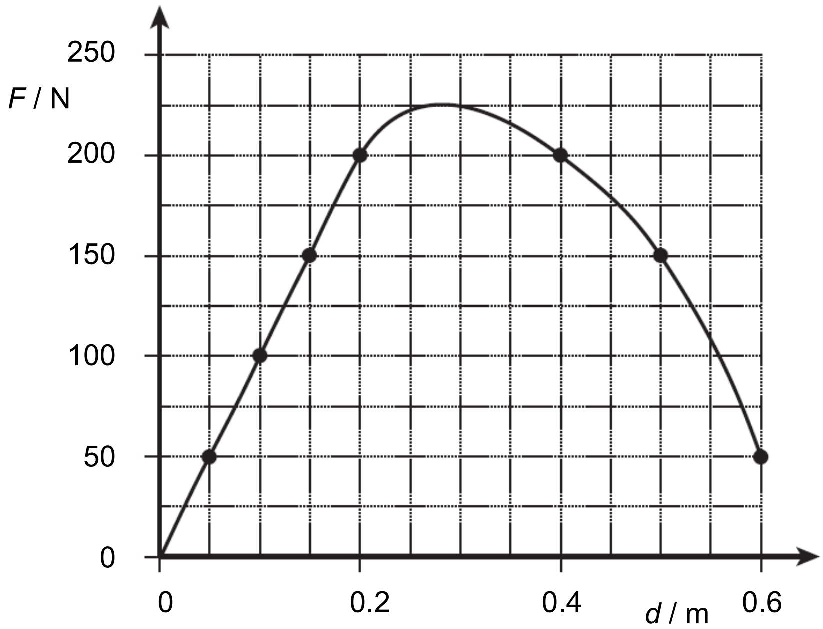

Fig. 2.2

(a) An experienced archer is able to draw an arrow further back, resulting in a greater displacement of arrow, *d*, as compared to a novice archer.

Using Fig. 2.2 and the principle of conservation of energy, suggest an advantage that this extra displacement provides.

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……………………………………………………………………………………………………..

…………………………………………………………………………………………………… [2]

(b) **(i)** Using Fig. 2.2, estimate the elastic potential energy stored in the bow when an arrow is displaced by 0.50 m.

elastic potential energy = ………………………… J [2]

(ii) The arrow in **(b)(i)** is then released by the archer from the bow.

Determine the maximum possible speed of the arrow which has a mass of 3.5×10^{-2} kg.

maximum possible speed = ………………………… m s^{-1} [2]

3 A light lever AB is hinged at C and attached to a cable at A. The lever is subjected to a 500 N horizontal force at point B and the angle between AB and the cable is 30°.

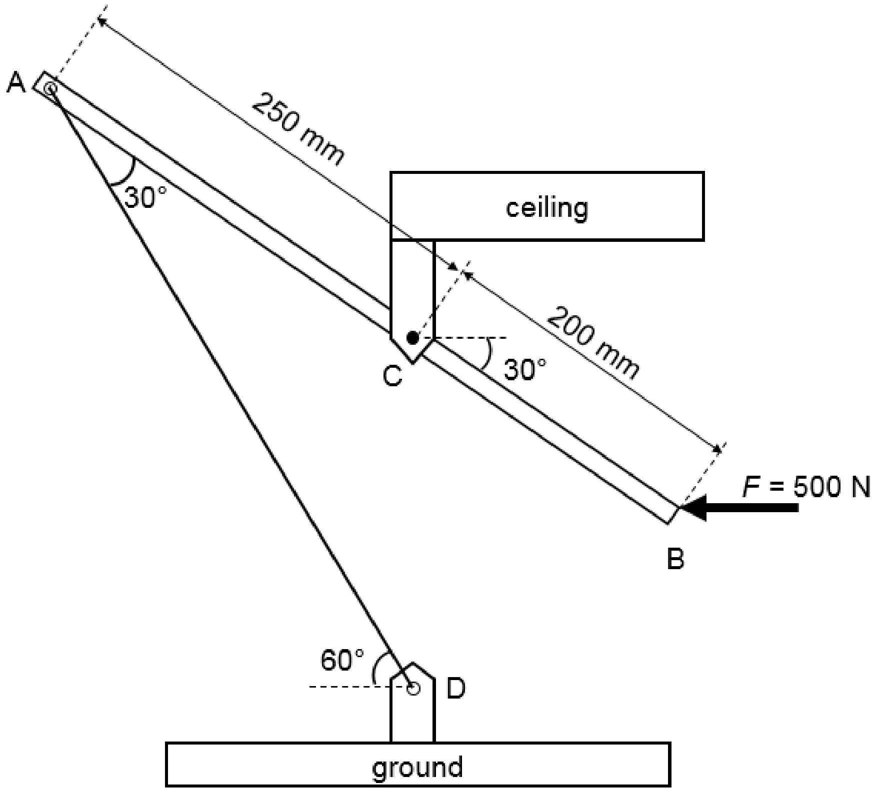

Fig. 3.1

(a) By taking moments at C, determine the tension in the cable.

tension = ………………………… N [3]

(b) Determine the magnitude of the reaction force at C.

reaction force = ………………………….. N [3]

4 A satellite is in a circular orbit of radius *r* about the Earth of mass *M*, as illustrated in Fig. 4.1.

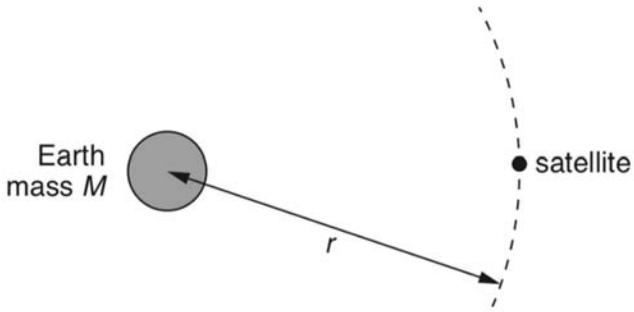

Fig. 4.1

The mass of the Earth may be assumed to be concentrated at its centre.

(a) Show that the period *T* of the orbit of the satellite is given by the expression

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

where *G* is the gravitational constant. Explain your working.

[3]

(b) (i) A satellite in geostationary orbit appears to remain above the same point on the Earth and has a period of 24 hours.

State two other features of a geostationary orbit.

1. ....

.... [1]

2. ....

.... [1]

(ii) The mass M of the Earth is 6.0×10^{24} kg. Use the expression in **(a)** to determine the radius of a geostationary orbit.

radius = …………………………… m [1]

(c) A global positioning system (GPS) satellite orbits the Earth at a height of 2.0×10^{4} km above the Earth's surface.

The radius of the Earth is 6.4×10^{3} km.

Use your answer in **(b)(ii)** and the expression

$$T^2 \propto r^3$$

to calculate, in hours, the period of the orbit of this satellite.

period = ……………………………….. hours [2]

5 A battery of e.m.f. E and internal resistance r is connected to a variable resistor, as shown in Fig 5.1.

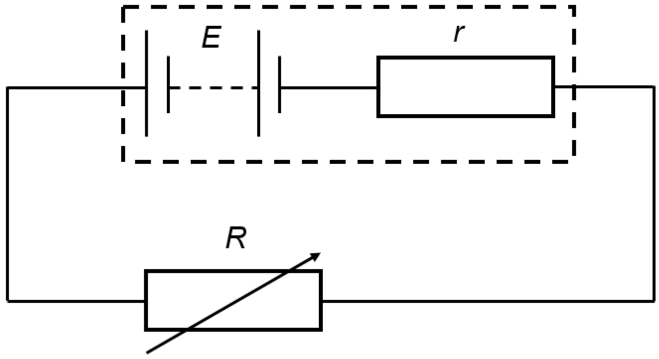

Fig 5.1

The total power produced in the battery is P_T. The power dissipated in the variable resistor is P_R.

The variations of P_T and of P_R with resistance R of the variable resistor are shown in Fig. 5.2.

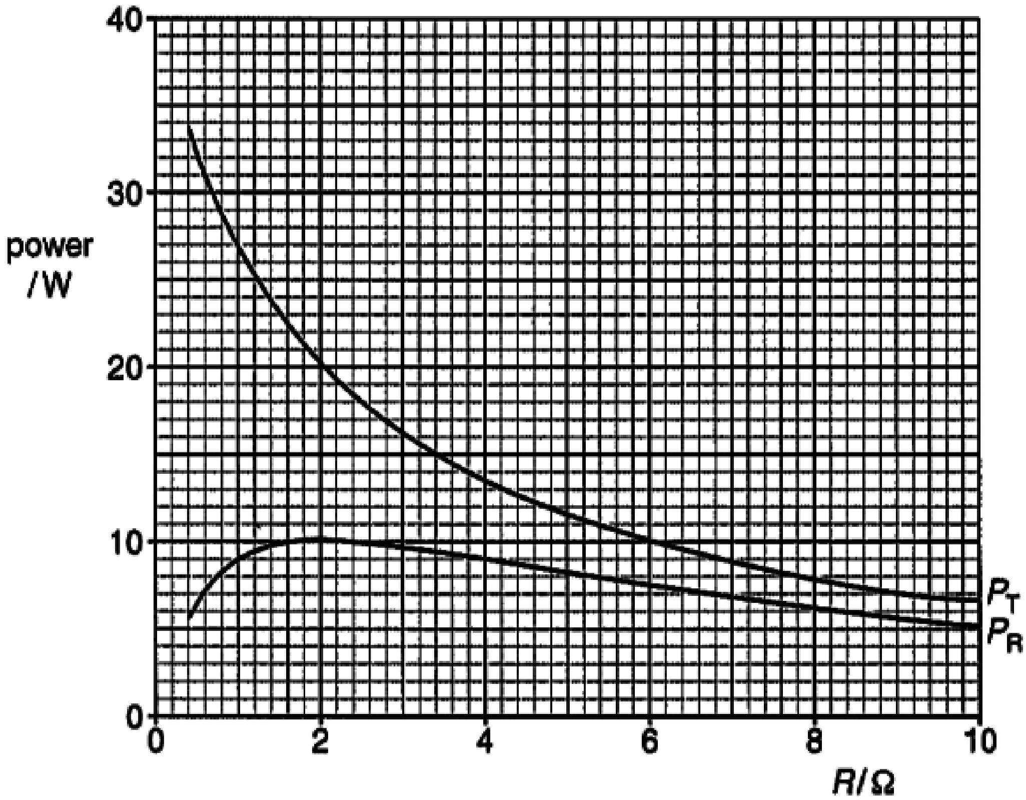

Fig. 5.2

(a) For resistance R = 4.0 Ω, use Fig. 5.2

(i) to show that the current in the circuit is 1.5 A, [2]

(ii) to determine the e.m.f. *E* of the battery.

E = ……………………… V [2]

(b) For any value of R, the value of P_T is greater than that of P_R.

(i) Suggest what is represented by the quantity ($P_T - P_R$).

…………………………………………………………………………………………..

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

(ii) Use the values of P_T and P_R at R = 4.0 Ω and your answer to **(a)(i)** to determine the internal resistance r of the battery.

r = ………………………… Ω [2]

(c) Using Fig. 5.2,

(i) state the value of R at which P_R is maximum.

R = ……………………........……….. Ω [1]

(ii) For the value of R stated in **(c)(i)**, determine the efficiency of power transfer from the battery to the variable resistor.

efficiency = ……………………........……….. % [1]

[Turn over

(d) **(i)** Determine the efficiency of power transfer from the battery to the variable resistor when R = 8 Ω.

efficiency = ……………………......……….. % [1]

(ii) A battery is designed to provide power for a component that has a fixed resistance. The internal resistance r of the battery is chosen to provide maximum efficiency of energy transfer to the component. Use your answers in **(c)(ii)** and **(d)(i)** to state and explain the choice of r compared with the component's fixed resistance R.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

6 **(a)** For a steady and streamline flow of an incompressible and non-viscous fluid, the total hydraulic head H of the flow through a particular cross-section of a pipe is given by the expression

$$H = \frac{P}{\rho g} + \frac{v^2}{2g} + h$$

where P is the pressure of the fluid at the cross-section,
ρ is the density of the fluid,
v is the velocity of the fluid at the cross-section, and
h is the height of the centreline of pipe above a reference level.

H is related the energy in the fluid.

Suggest the type of energy associated with the following terms:

(i) $\frac{v^2}{2g}$

.... [1]

(ii) h

.... [1]

(b) Fig. 6.1 shows a steady and fully developed flow through a horizontal pipe of varying diameter. The inlet has an inner pipe diameter D_A and fluid velocity V_A while the outlet has an inner pipe diameter D_B and fluid velocity V_B.

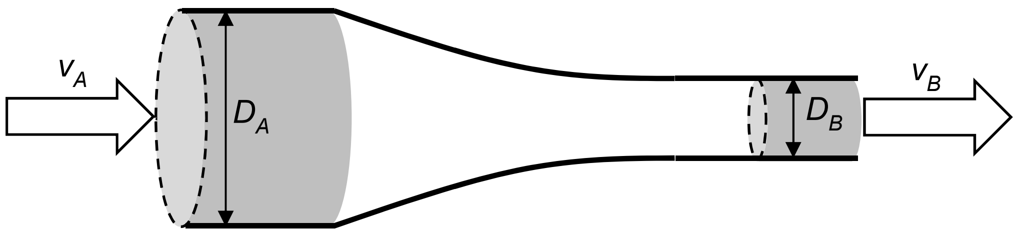

Fig. 6.1

(i) Assuming there are no energy losses within the pipe, state how the total hydraulic head at the inlet and at the outlet are related.

.... [1]

(ii) If the fluid can be considered incompressible, show that v_A and v_B are related by the expression

$$\frac{v_A}{v_B} = \frac{{D_B}^2}{{D_A}^2}$$

[2]

(iii) The inner diameter of the inlet is 0.100 m and the inner diameter of the outlet is 0.050 m. Water flows into the inlet at a speed of 8.0 m s^{-1}.

Using the hydraulic head expression given in **(a)** and your answers to **(b)**, determine the pressure difference between the inlet and outlet. (Density of water is 1000 kg m^{-3}.)

pressure difference = ………………………… Pa [3]

(c) In a typical flow between 2 cross-sections of a pipe, there will be energy losses due to frictional forces between the walls of the pipe and the fluid. This is accounted for by including an additional head loss term,

$$H_{Loss} = f_D \frac{v^2 L}{2gD}$$

where f_D is the friction factor,
L is the length of the pipe, and
D is the inner diameter of the pipe.

(i) State how this additional term will affect your answer to **(b)(iii)**.

....

.... [1]

(ii) If the pipe in **(b)** has a length of 10 m and a friction factor of 0.0038, estimate the magnitude of the difference to your answer in **(b)(iii)** if frictional losses are considered.

difference = ………………………… Pa [2]

(d) A student suggests using water flow in rigid pipes to model blood flow in blood vessels.

(i) State two differences between water flow in rigid pipes and blood flow in blood vessels.

1. ……………………………………………………………………………………………………

……………………………………………………………………………………………………..

2. ……………………………………………………………………………………………………

…………………………………………………………………………………………………. [2]

(ii) The accumulation of fat and cholesterol deposits along the arterial walls has an effect of narrowing the arteries leading to an increase in blood pressure.

State and explain if the modelling proposed by the student will able to correctly predict this observation.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………… [3]

Section B

Answer **one** question from this Section in the spaces provided.

7 **(a)** In an α-particle scattering experiment, α-particles are directed at a gold foil as illustrated in Fig. 7.1.

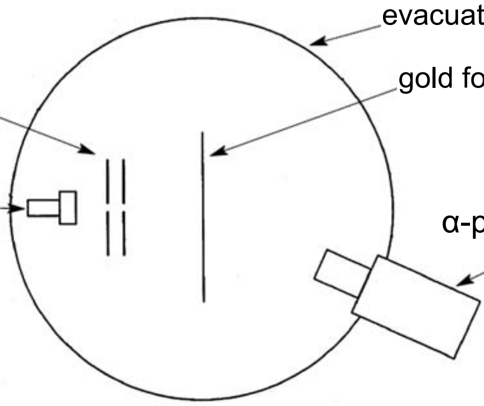

Fig. 7.1

(i) **1.** Give one reason why the gold foil should be thin.

....

.... [1]

2. Explain why the incident beam of α-particles should be narrow.

....

.... [1]

3. Explain why the chamber must be evacuated.

....

.... [1]

(ii) The results of the α-particle scattering experiment provides evidence for the structure of the atom.

result 1: The vast majority of α-particles pass straight through the gold foil or are deviated by small angles.

result 2: A very small minority of α-particles are scattered through angles greater than 90^o and up to 180^o.

State what may be inferred from

1. result 1,

....

.... [1]

2. result 2.

....

....

....

.... [2]

(b) One nuclear reaction that can take place in a nuclear reactor may be represented, in part, by the equation

$$^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{95}_{42}\text{Mo} + ^{139}_{57}\text{La} + 2^{1}_{0}\text{n} + \text{..........} + \text{energy}$$

Data for a nucleus and some particles are given in Fig. 7.2

nucleus or particle	mass / u
$^{139}_{57}\text{La}$	138.955
$^{1}_{0}\text{n}$	1.00863
$^{1}_{1}\text{p}$	1.00728
$^{0}_{-1}\text{e}$	0.000549

Fig. 7.2

(i) Complete the nuclear reaction shown above. [1]

(ii) Calculate the binding energy per nucleon, in MeV, of lanthanum-139 $\left(^{139}_{57}\text{La}\right)$.

binding energy per nucleon = ………………………… MeV [3]

(iii) State and explain whether the binding energy per nucleon of uranium-235 $\left({}^{235}_{92}U\right)$ will be greater, equal to or less than your answer to **(b)(ii)**.

....

....

....

.... [2]

(c) A radiation detector is placed close to a radioactive source as shown in Fig. 7.3.

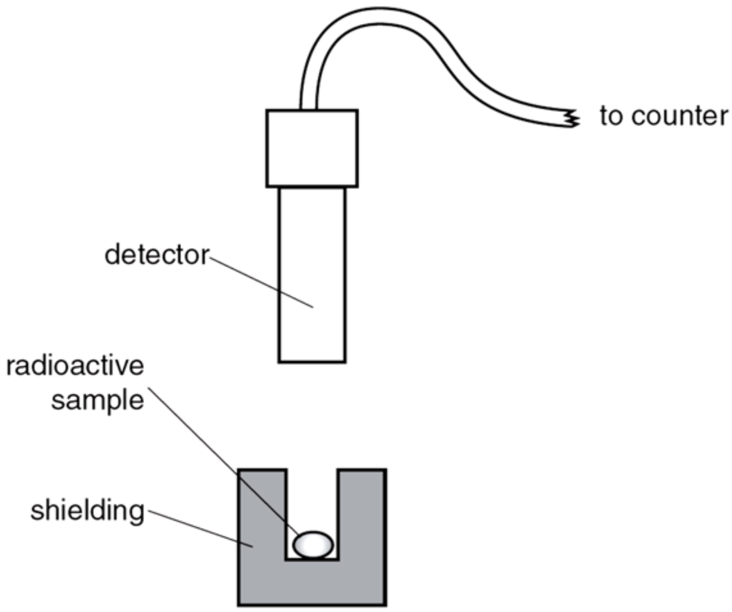

Fig. 7.3

The emissions from the radioactive source include both β-particles and γ-ray photons.
The β-particles emitted have energies up to a maximum of 0.61 MeV.

(i) Suggest two reasons why the activity of the source and the measured count rate may be different.

1. ....

....

2. ....

.... [2]

(ii) Explain why the emitted β-particles have a range of energies.

....

.... [1]

(d) The variation with time t of the measured count rate in **(c)** is as shown in Fig. 7.4.

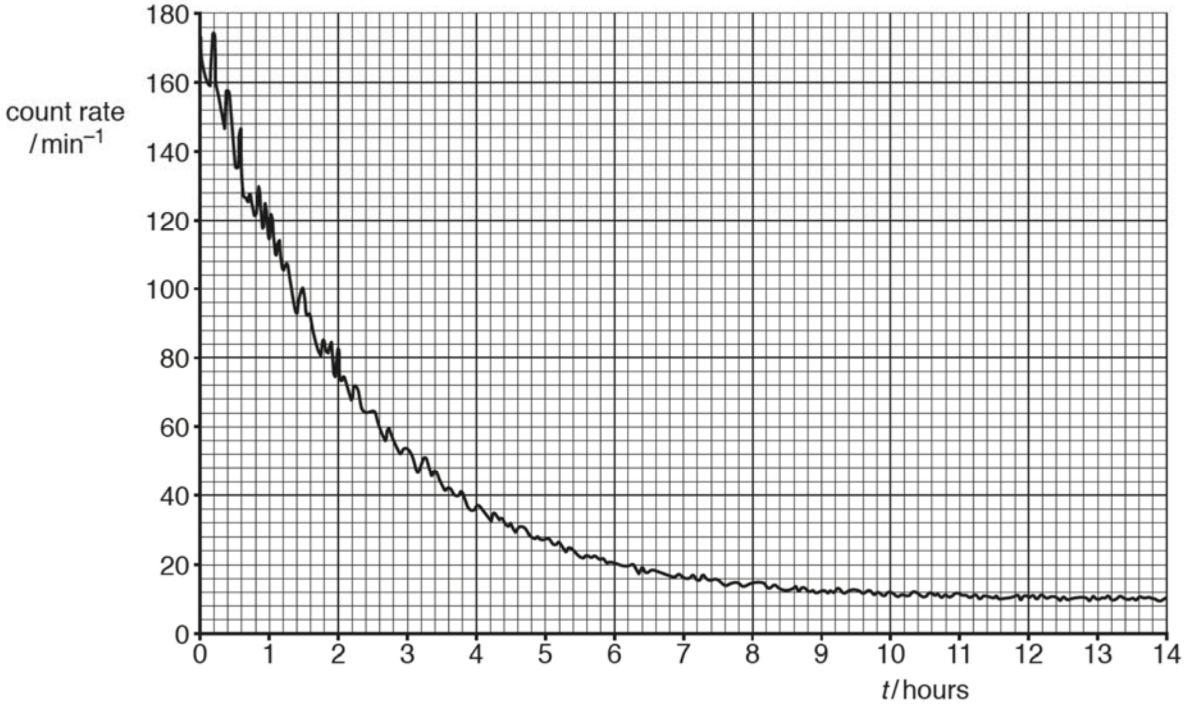

Fig. 7.4

(i) Use Fig. 7.4 to determine the half-life of the radioactive source.

half-life = ... hours [3]

(ii) The readings in Fig. 7.4 were obtained at room temperature.

A second sample of this radioactive source is heated to a temperature of 500°C. The initial count rate at time t = 0 is the same as that in Fig. 7.4. The variation with time t of the measured count rate from the heated source is determined.

State and explain if there is any difference in

1. the half-life,

....

.... [1]

2. the measured count rate for any specific time.

....

.... [1]

End of Question 7

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

....

....

.... [1]

(b) Charged particles, of speed 4500 m s^{-1} and mass 2.66×10^{-26} kg, are travelling in a narrow beam in a vacuum as shown in **Fig. 8.1**.

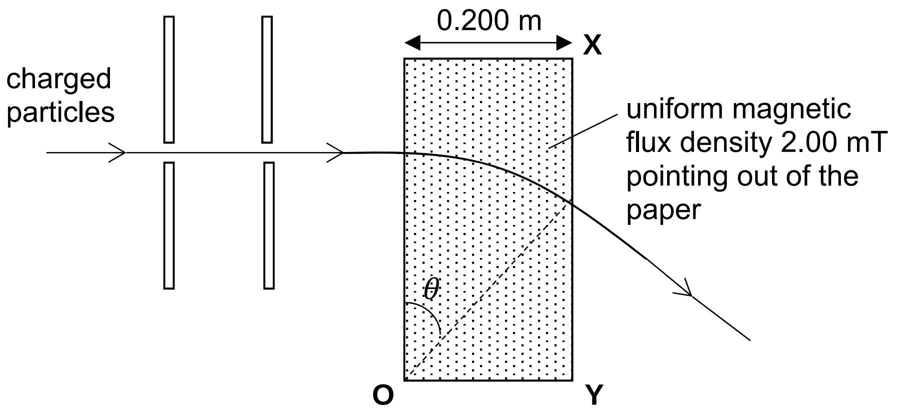


Fig. 8.1

The charged particles enter a region of uniform magnetic flux density which is 0.200 m wide. The direction of the magnetic flux is pointing out of the paper.

(i) Using Newton's Law of motion, state and explain the speed of the particle as it exits the uniform magnetic field.

....

....

....

.... [2]

(ii) Given that the magnitude of the charge of the particles is *e*, calculate the radius of the circular motion of the charged particles in the uniform magnetic field.

radius = ……………………… m [2]

(iii) Hence, calculate the angular velocity of the charged particles in the uniform magnetic field.

angular velocity = …………………… rad s^{-1} [1]

(iv) Point **O** is the center of the circular motion of the charged particles as shown in **Fig. 8.1**. Show that the angle θ is 0.564 rad.

[2]

(v) In another experiment, similar charged particles are now fired into the magnetic field in **Fig. 8.1** with different momentum.

1. Determine the maximum momentum of particles such that the particle will not exit the magnetic field through XY.

momentum = …………………… kg m s^{-1} [2]

2. Show that the time taken t for the particle of mass m and charge q in **(b)(v)1** to complete a semi-circle within a region of magnetic flux density B is given by:

$$t = \frac{\pi m}{Bq}$$

[2]

(c) Define *electric field strength*.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

…………………………………………………………………………………………………… [1]

(d) Fig. 8.2 shows two plates P and Q placed 40 mm apart in a vacuum. Plate P is at a potential of −4.2 V and plate Q is grounded.

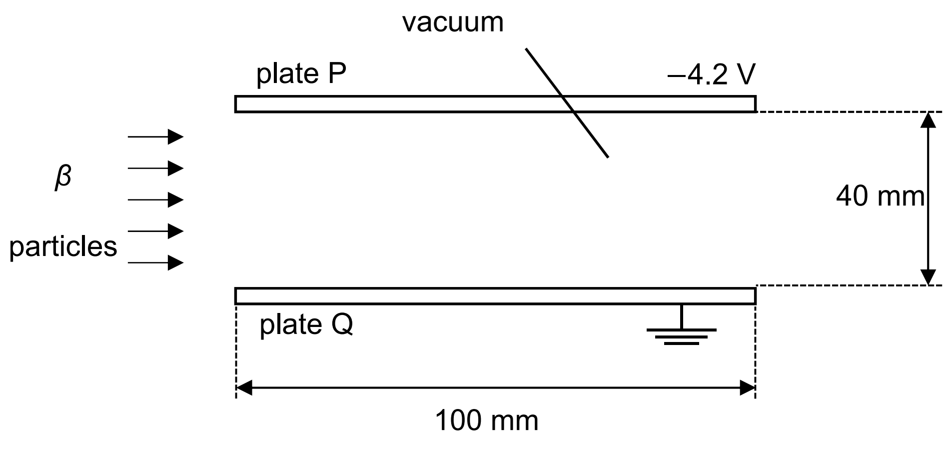


Fig. 8.2

(i) Sketch the field lines representing a uniform electric field in between plates P and Q in Fig. 8.2. [1]

(ii) A stream of β-particles with constant horizontal velocity is projected into the region of uniform electric field in between plates P and Q. The electric field strength between plates P and Q is 105 V m^{-1}. Calculate

1. the acceleration experienced by each β-particle

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

direction: ……………………………….. [1]

2. the maximum duration for a β-particle to move from plate P to plate Q.

duration = ……………………………… s [1]

3. Hence or otherwise, determine the maximum horizontal speed the β-particles can have, such that all of the particles are captured by plate Q.

maximum speed =………………………………. m s^{-1} [1]

(iii) Describe the changes to trajectory, if any, if β-particles were replaced by α-particles.

……

……

……

………………………………………………………………………………………………………... [2]

End of Question 8

End of Paper

EUNOIA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS 2018
General Certificate of Education Advanced Level
Higher 1

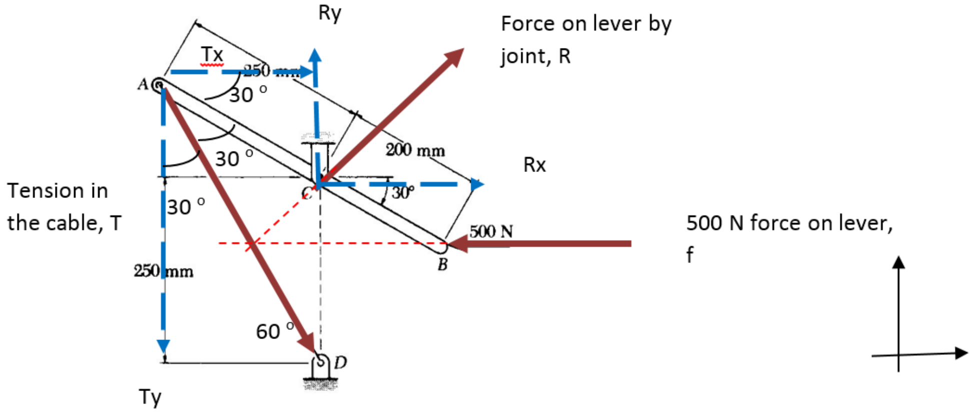
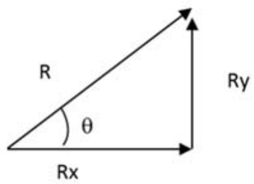
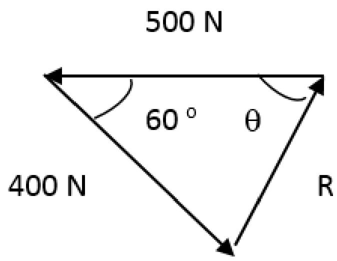
PHYSICS 8867/02

Paper 2 Structured Questions
MARK SCHEME
Maximum Mark: 80

14 September 2018

Qns	Answer	Marks
1(a)	N1L: An object at rest will remain at rest and an object in motion will remain in motion at constant velocity in the absence of an external resultant force. N2L: The rate of change of momentum of a body is directly proportional to the resultant force acting on the body and occurs in the direction of the resultant force. N3L: If body A exerts a force on body B, then body B exerts a force of the same type that is equal in magnitude and opposite in direction on body A.	B1 B1 B1
1(b)(i)	Initially, suitcase moving with same velocity as bus before braking By N1L, suitcase will continue to move forward in the absence of external force acting on it when brakes applied Claim invalid	B1 B1 A0
1(b)(ii)	The two equal and opposite forces act on cart and labourer separately	B1
	Cart pulled forward by the force applied by the labourer on the cart. Labourer moved forward by the frictional force between feet/shoes and ground. Reasoning false	B1 A0
1(b)(iii)	Throw bag of gold in direction away from shore By N3L, man experiences a force equal in magnitude and opposite in direction from the force he exerted on the bag of gold. This forces accelerates the man towards shore during pushing, thereafter he will glide over ice at constant speed	B1 B1
1(c)(i)	By N3L, force experienced by car same as force experienced by truck	B1
1(c)(ii)	Total mass of truck and its driver larger than total mass of car and its driver truck and its driver experiences smaller change in velocity over same duration of time Safety belt exert smaller force on truck driver in stopping his forward velocity Truck driver likely less injured than car driver	B1 B1 A0

Qns	Answer	Marks
2(a)	Area under F-x graph is w.d. in stretching bow. More potential energy is stored Arrows gain more KE, has less deviation from intended flight path / more accurate OR Arrows gain more KE, has further range OR Arrow hits target faster Comments: Failed to state area under graph relates to Elastic potential energy. Most get marks for stating effect of arrow.	B1 B1
2(b)(i)	By counting squares under F-x graph, Elastic potential energy = area under F-x graph = 1.25 J × 65 =81 J Acceptable to +/- 2 squares Comment: Many did not realise that Elastic PE can be calculated as area under Fx graph and used the formula $PE = \frac{1}{2}kx^2$ indiscriminately to calculate elastic PE which is obviously wrong since the bow does not follows Hooke's Law.	M1 A1
2(b)(ii)	By Conservation of Energy, Loss in PE = Gain in KE for arrow $81 = \frac{1}{2}\left(3.5\times10^{-2}\right)v^2$ v = 68.0 m s^{-1} Comments: Well done for all. Accepted error carry forward from (b)(i)	M1 A1
3(a)	Taking moment about C. By principle of moments, the sum of clockwise moments = sum of anti-colockwise moments T × (0.25 × sin 30°) = 500 × 0.2 sin 30° T = 500 × 0.2/0.25 = 400 N	 M1 M1 A1

Qns	Answer	Marks
3(b)		1
	Method 1: Resolving the forces:	
	Vertically: $-T\cos 30^{o} + R_y = 0$ $400\cos 30^{o} = R_y$ $R_y = 346.4\text{ N} = 350\text{ N}$	 1 1
	Horizontally: $R_x + T\sin 30^{o} - 500 = 0$ $R_x = 500 - 400\sin 30^{o} = 300\text{ N}$  $R = \sqrt{R_x^2 + R_y^{\ 2}} = \ldots = 458.3\text{ N} = 460\text{ N}$ $\tan\theta = R_y/R_x$ $\theta = 49.1^{o}$ anti-clockwise with respect to the horizontal.	
	Method 2:	1
		1
	Using cosine rule: $R^2 = 400^2 + 500^2 - 2\times400\times500\times\cos 60^{o}$ $R = 458.3\text{ N}$ {1} $\sin\theta \div 400 = \sin 60^{o} \div 458.3$ $\theta = 49.1^{o}$	

Qns	Answer	Marks
4(a)	gravitational force provides/is the centripetal force $GMm / r^2 = mv^2 / r$ *or* $GMm / r^2 = mr\omega^2$ **and** $v = 2\pi r / T$ *or* $\omega = 2\pi / T$ with algebra to $T^2 = 4\pi^2 r^3 / GM$ *or* acceleration due to gravity is the centripetal acceleration $GM / r^2 = v^2 / r$ *or* $GM / r^2 = r\omega^2$ **and** $v = 2\pi r / T$ *or* $\omega = 2\pi / T$ with algebra to $T^2 = 4\pi^2 r^3 / GM$	B1 M1 A1 (B1) (M1) (A1)
4(b)(i)	From west to east Equatorial orbit/orbits(directly) above the equator	B1 B1
4(b)(ii)	$T^2 = \frac{4\pi^2 r^3}{GM}$ $(24 \times 60 \times 60)^2 = \frac{4\pi^2 r^3}{(6.67 \times 10^{-11})(6.0 \times 10^{24})}$ $r = 4.23 \times 10^7\ m$	A1
4(c)	$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{r_1}{r_2}\right)^3$ $\left(\frac{24}{T_2}\right)^2 = \left(\frac{4.23 \times 10^7}{6.4 \times 10^6 + 2 \times 10^7}\right)^3$ $T_2 = 11.8\ hr$	M1 A1
5(a)(i)	When R = 4.0 Ω, P_R = 9.0 W. Using $P_R = I^2R$, $I^2 = P_R/R$ = 9.0/4.0, I = 3.0/2.0 = 1.5 A Comments: Well done for all	M1 A1
5(a)(ii)	When R = 4.0 Ω, P_T = 13.5 W. Using P_T = I E, E = P_T/I = 13.5/1.5 = 9.0 V Comments: Well done for all	M1 A1
5(b)(i)	The quantity (P_T – P_R) represents the power dissipated in the internal resistance r of the battery. Comments: Well done for all	B1
5(b)(ii)	Using $P_r = P_T - P_R$, $P_r = I^2r$, $(1.5)^2r$ = 13.5 – 9.0, r = 2.0 Ω Comments: Well done for all	 M1 A1
5(c)(i)	When P_R is maximum, R = 2.0 Ω Acceptable range 1.9 to 2.1. Comments: Well done for all	B1

Qns	Answer	Marks
5(c)(ii)	When R = 2.0 Ω, P_T = 20.0 W, P_R = 10.0 W. Efficiency = P_R/P_T = 10.0/20.0 = 0.50 = 50 % Comments: Well done for most	M0 A1
5(d)(i)	When R = 8.0 Ω, P_T = 8.0 W, P_R = 6.0 W. Efficiency = P_R/P_T = 6.0/8.0 = 0.50 = 75 % Comments: Well done for most	M0 A1
5(d)(ii)	As efficiency of power transfer increases from 50% to 75% as *R* increased from 2.0 Ω to 8.0 Ω, to obtain as high an efficiency as possible, *r* must be much smaller compared to the value of *R* Additional Information: $\text{efficiency} = \dfrac{\text{power dissipated in } R}{\text{power supplied by battery}}$ $= \dfrac{I^2R}{I^2R+I^2r} = \dfrac{R}{R+r} = \dfrac{1}{1+r/R}$ As R → ∞, r/R → 0, efficiency →1. Comments: Many failed to use answers from previous part to compare and arrive at the conclusion as required by the question.	M1 A1
6(a)(i)	kinetic energy (of the fluid)	B1
6(a)(ii)	gravitational potential energy (of the fluid)	B1
6(b)(i)	They are the same/ equal.	B1
6(b)(ii)	mass flow (rate) at inlet = mass flow (rate) at outlet $\dfrac{m_A}{t} = \dfrac{m_B}{t}$ $\dfrac{\rho \frac{\pi D_A{}^2}{4} l_A}{t} = \dfrac{\rho \frac{\pi D_B{}^2}{4} l_B}{t}$ $D_A{}^2 v_A = D_B{}^2 v_B$ $\dfrac{v_A}{v_B} = \dfrac{D_B{}^2}{D_A{}^2}$	B1 B1
6(b)(iii)	$\dfrac{v_{out}}{v_{in}} = \dfrac{D_{in}{}^2}{D_{out}{}^2}$ $v_{out} = \left(\dfrac{0.100}{0.050}\right)^2 v_{in}$ $= 4v_{in}$	C1 M1

Qns	Answer	Marks
	$\frac{P_{in}}{\rho g}+\frac{v_{in}^2}{2g}+h_{in}=\frac{P_{out}}{\rho g}+\frac{v_{out}^2}{2g}+h_{out}$ $\frac{P_{out}-P_{in}}{\rho g}=\frac{v_{in}^2-v_{out}^2}{2g}$ $\Delta P=\frac{\rho\left(v_{in}^2-v_{out}^2\right)}{2}$ $=\frac{\rho\left(v_{in}^2-\left(4v_{in}\right)^2\right)}{2}$ $=-480\text{ kPa}$	A1
6(c)(i)	The pressure difference will be higher.	B1
6(c)(ii)	$v_{ave}=2.5v_{in}$ $D_{ave}=0.075\text{ m}$ (or any other appropriate averaging done) $H_{Loss}=f_D\frac{v_{ave}^2L}{2gD_{ave}}$ $=0.0038\times\frac{(2.5\times8)^2\times10}{2\times9.81\times0.075}$ $=101\text{ kPa}$	C1 A1
6(d)(i)	✓ Blood vessels are flexible ✓ (Higher) friction factor / viscosity of blood ✓ Blood is a suspension rather than a pure fluid. ✓ Capillary action due to the small diameter of blood vessels.	Any 2 B1 each
6(d)(ii)	As the arteries narrow, the model predicts that the velocity of the flow at this cross section will be higher. From the expression in (a), the pressure of the blood at the narrow cross-section will be lower. Thus, this model proposed by the student will not be able to correctly predict this observation.	M1 M1 A1
7(a)(i)1.	✓ less likelihood of α-particles being absorbed / α-particles are able to penetrate the foil. ✓ α-particles are only scattered once	B1
7(a)(i)2.	✓ scattering angle can be determined accurately. ✓ have a definite location where the scattering takes place	B1
7(a)(i)3.	✓ the α-particles do not collide with the air molecules, thus losing energy.	B1
7(a)(ii)1.	most of the atom is empty space **or** the size of the nucleus is very small compared to the size of the atom	B1
7(a)(ii)2.	the nucleus is positively charged the mass is concentrated in the nucleus	B1 B1
7(b)(i)	$7\ {}^{0}_{-1}e$	A1
7(b)(ii)	mass defect = [(82 × 1.00863) + (57 × 1.00728) – 138.955]u = 1.16762u binding energy per nucleon	C1

Qns	Answer	Marks
	$= \dfrac{1.16762 \times 1.66 \times 10^{-27} \times \left(3.0 \times 10^{8}\right)^{2}}{139 \times \left(1.60 \times 10^{-19}\right)}$ $= 7.84$ MeV	M1 A1
7(b)(iii)	Since the fission reaction releases energy, the binding energy of uranium must be lower than for the products **or** Above A = 56, binding energy per nucleon decreases as A increases. Since U-235 has a larger nucleon number (compared to La-139), it must have a higher binding energy per nucleon.	M1 A1 M1 A1
7(c)(i)1. 7(c)(i)2.	✓ radiation emitted in all directions ✓ background radiation ✓ emission from radioactive daughter products ✓ window of detector may absorb some radiation ✓ self-absorption in source	Any 2 B1 each
7(c)(ii)	the energy is shared with a(n) (anti)neutrino	B1
7(d)(i)	Background count = 10 min^{-1} After 3 T_{half}, count rate will be 30 min^{-1} Hence 3 T_{half} = 4.5 hours T_{half} = 1.5 hours (1.4 to 1.6 hours)	B1 M1 A1
7(d)(ii)1.	no change as radioactive decay is spontaneous / independent of environment.	B1
7(d)(ii)2.	likely to be different as radioactive decay is random (and cannot be predicted).	B1
8(a)	SI unit of magnetic flux density. One tesla is when there is a force of one newton per unit length conductor per unit current that is of a direction normal to the uniform magnetic flux density.	B1
8(b)(i)	Charged particles moving not parallel to a magnetic field, it will experience a resultant magnetic force perpendicular to its motion. Hence no work is done. By N2L, forces changes direction but not speed	B1 B1
8(b)(ii)	Magnetic force provides centripetal force for particle's circular motion $F = Bqv = \dfrac{mv^2}{r}$ $r = \dfrac{mv}{Bq}$ $= \dfrac{\left(2.66 \times 10^{-26}\right)(4500)}{\left(2 \times 10^{-3}\right)(1.6 \times 10^{-19})}$ = 0.374 m	M1 A1
8(b)(iii)	$v = r\omega$ $\omega = \dfrac{v}{r} = \dfrac{4500}{0.374}$ =12030 rad s^{-1}	M1 A1

Qns	Answer	Marks
8(b)(iv)	$\sin\theta = \frac{OX}{r}$ $\theta = \sin^{-1}\left(\frac{0.2}{0.374}\right)$ =0.574 rad	M1 A1
8(b)(v)1.	$r = \frac{mv}{Bq} = \frac{P}{Bq}$ $P = rBq = (0.2)(2\times10^{-3})(1.6\times10^{-19})$ = 6.4 x10^{-23} kg m s^{-1}	M1 A1
8(b)(v)2.	magnetic force F provides centripetal force for the particle's circular motion $F = Bqv = mr\omega^2$ $Bq(r\omega) = mr\omega^2$ $Bq = m(\frac{2\pi}{T})$ $T = 2\pi\frac{m}{Bq}$ For semicircle, $t = \frac{T}{2} = \frac{\pi m}{Bq}$	M1 A1
8(c)	<u>electric force *per unit* positive charge</u> experienced by a <u>small stationary test charge</u> placed at that point.	B1
8(d)(i)	at least 4 straight lines perpendicular to, and touching plates <u>pointing upwards, equally spaced</u>	B1
8(d)(ii)1.	$a = \frac{F}{m_e} = \frac{Q_eE}{m_e} = \frac{(1.6\times10^{-19})(105)}{9.11\times10^{-31}}$ = 1.84 × 10^{13} m s^{-2} Downwards	B1 B1
8(d)(ii)2.	$s_y = ut + \frac{1}{2}at^2$ $t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2(40\times10^{-3})}{1.84\times10^{13}}}$ = 6.59 × 10^{-8} s	 B1
8(d)(ii)3.	$v_x = \frac{s_x}{t} = \frac{100\times10^{-3}}{6.59\times10^{-8}}$ = 1.52 × 10^{6} m s^{-1}	B1
8(d)(iii)	(as the alpha are positively charged) direction of <u>electric force experienced is upwards</u>, so <u>trajectory curve upwards/towards</u> plate P (as the alpha particles are more massive) <u>magnitude of acceleration</u> experienced is less so <u>curvature less / more gradual</u> [do not accept "path is straighter"]	 B1 B1