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Tasmanian Secondary Assessment Board

Tasmanian Certificate of Education

External Assessment

2002

PH866 PHYSICS

SECTION A

Time: 45 minutes

On the basis of your performance in this examination, the examiners will provide a rating of A, B, C or D on each of the following criteria taken from the syllabus statement:

Criterion 2 Convey information in a variety of ways using established conventions and appropriate language.

Criterion 7 Formulate generalisations and make realistic predictions based on experimental data.

Pages: 12
Questions: 2

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CANDIDATE INSTRUCTIONS

Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

Recommended time:

Section A – 45 minutes.

The PH866 Physics Formula Sheet can be used throughout the examination.

No other printed material is allowed into the examination.

The following will be taken into account when determining your assessment on Criterion 2:

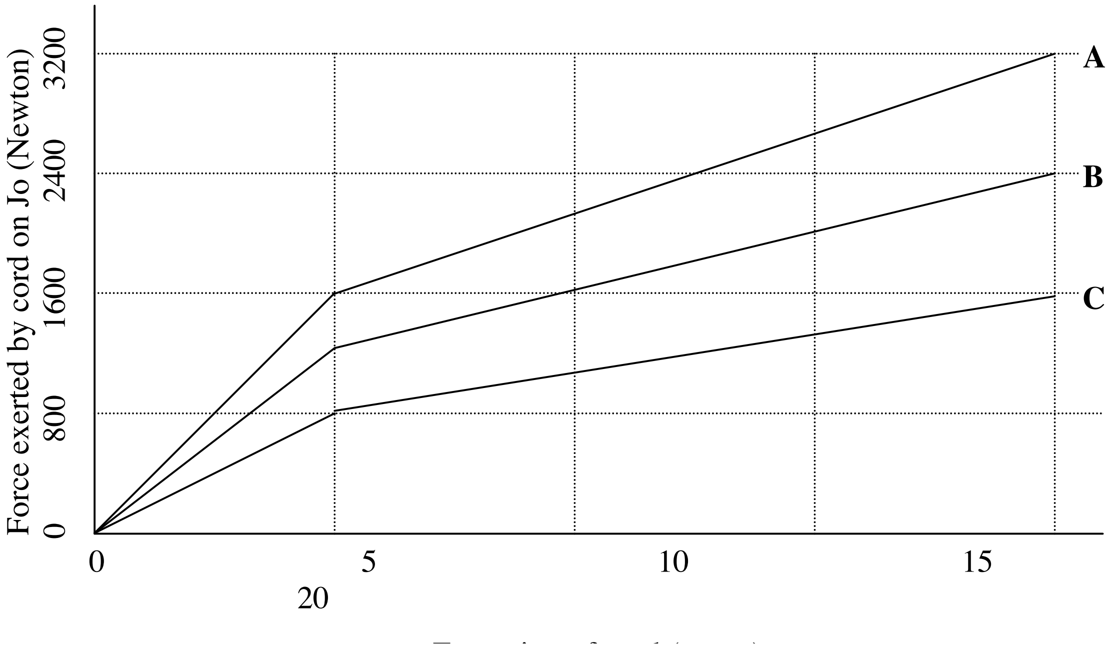
- numerical answers should have appropriate units and significant figures;
- vectors should have magnitude and direction;
- graphs should be in pencil and have appropriate scales, labelled axes, units, heading, clear point placement and a suitable line of best fit;
- diagrams should be used when appropriate (especially with vectors);
- answers should be clearly and logically explained.

A set of spare diagrams has been provided in the back of the answer booklet for you to use if required. If you use a spare diagram, please indicate you have done so in your answer to that question.

Question 1 (You should spend about 13 minutes in total on this question.)

In the sport of Bungee Jumping, a person (whom we will call 'Jo') attached to a long elastic cord jumps from a high bridge. By design, the elastic cord will prevent Jo from reaching the ground below.

The graph below shows the **force** exerted by the elastic cord (on Jo) against the **extension** of the cord for three different cords A, B and C. In each case the maximum safe extension of the cord is 20 m. The cord that is actually used in the jump is chosen to match the mass of Jo.



(a) The **slope** of a graph of force against extension for an elastic cord is known as the **stiffness** of the cord. Which of the above cords displays the greatest stiffness over the first 5 m of extension, and what is the value of this maximum stiffness? Ensure that you to give units for your answer. (2 minutes)

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(b) The three cords are designed to be used by people of large, medium and small body mass. Which cord would be chosen if Jo has a 'large' body mass. Give your reasons. (2 minutes)

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Question 1 continues opposite.

Question 1 (continued)

(c) Recall that energy is equal to area under a force versus distance graph.

Determine the total potential energy stored in cord **C** when it is at its maximum extension of 20m. (3 minutes)

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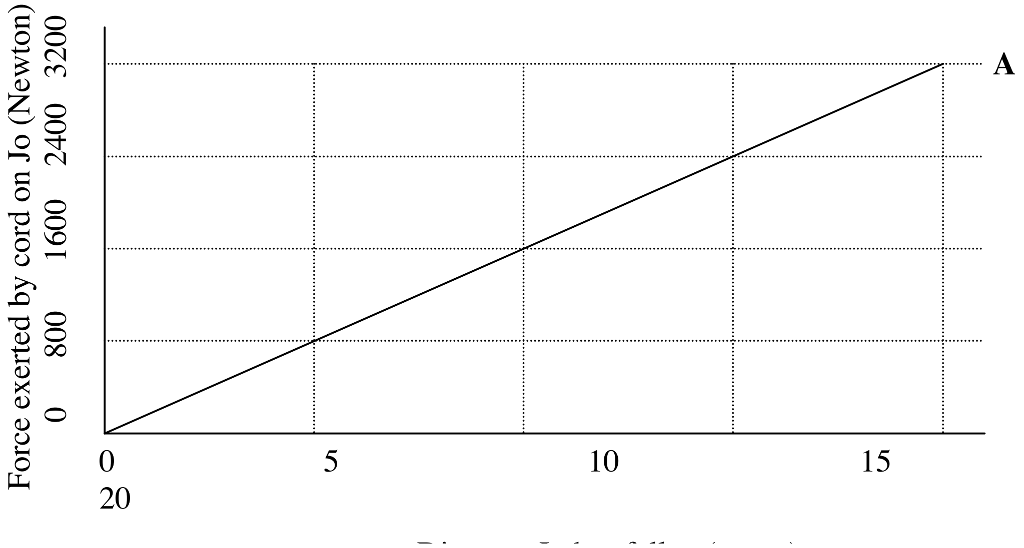
(d) The graph below gives a much simplified version of the above graph for the chord **A**, showing the force exerted by the cord on Jo against the distance Jo has fallen.



(i) The **gravitational force** on Jo is constant at 1200 N. Superimposed on the above graph, draw the graph of gravitational force on Jo against distance Jo has fallen. (2 minutes)

(ii) After Jo has jumped, Jo's velocity will equal zero when the potential energy stored in the cord is equal to the gravitational potential energy lost by Jo. Use the above graphs to show that Jo will fall a distance 15 m before Jo's velocity equals zero. Explain your reasoning. (4 minutes)

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Question 2 (You should spend about 32 minutes in total on this question.)

The data given below relates the potential energy of a 1.0 kg mass to its distance from the centre of an earth like planet. The blank spaces are for you to fill in later.

Potential Energy (10^7J)	-4.35	-3.86	-3.09	-2.47	-2.06	-1.54
Distance (10^6 m)	7.0	8.0	10.0	12.5	15.0	20.0

The theoretical formula relating potential energy of a 1.0 kg mass to its distance r from the centre of the planet is:

$$PE = -\frac{GM}{r}$$

PE = potential energy (Jkg^{-1})
G = universal gravitational constant = 6.67×10^{-11} $Nm^2 kg^{-2}$
M = mass of planet (kg)

(a) Modify the above data to enable you to plot a straight line graph relating PE and r. Write your modified data in the blank spaces in the table above. (5 minutes)

(b) Plot the straight line graph relating PE and r on the graph on page 7.

Use your straight line graph to determine the mass of the planet. (10 minutes)

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Question 2 continues opposite.

Question 2(continued)

Graph for Question 2(b)

Spare Graph for Question 2(b)

Question 2 continues over the page.

Question 2(continued)

(c) The data relating potential energy and distance is plotted on the graph shown below. The slope (or 'rate of change') of this graph is equal to the **force** acting on the 1.0 kg object. *Use the graph* to determine the force acting on a 1.0 kg object at a distance of 1.5×10^7 m from the centre of the planet. (5 minutes)

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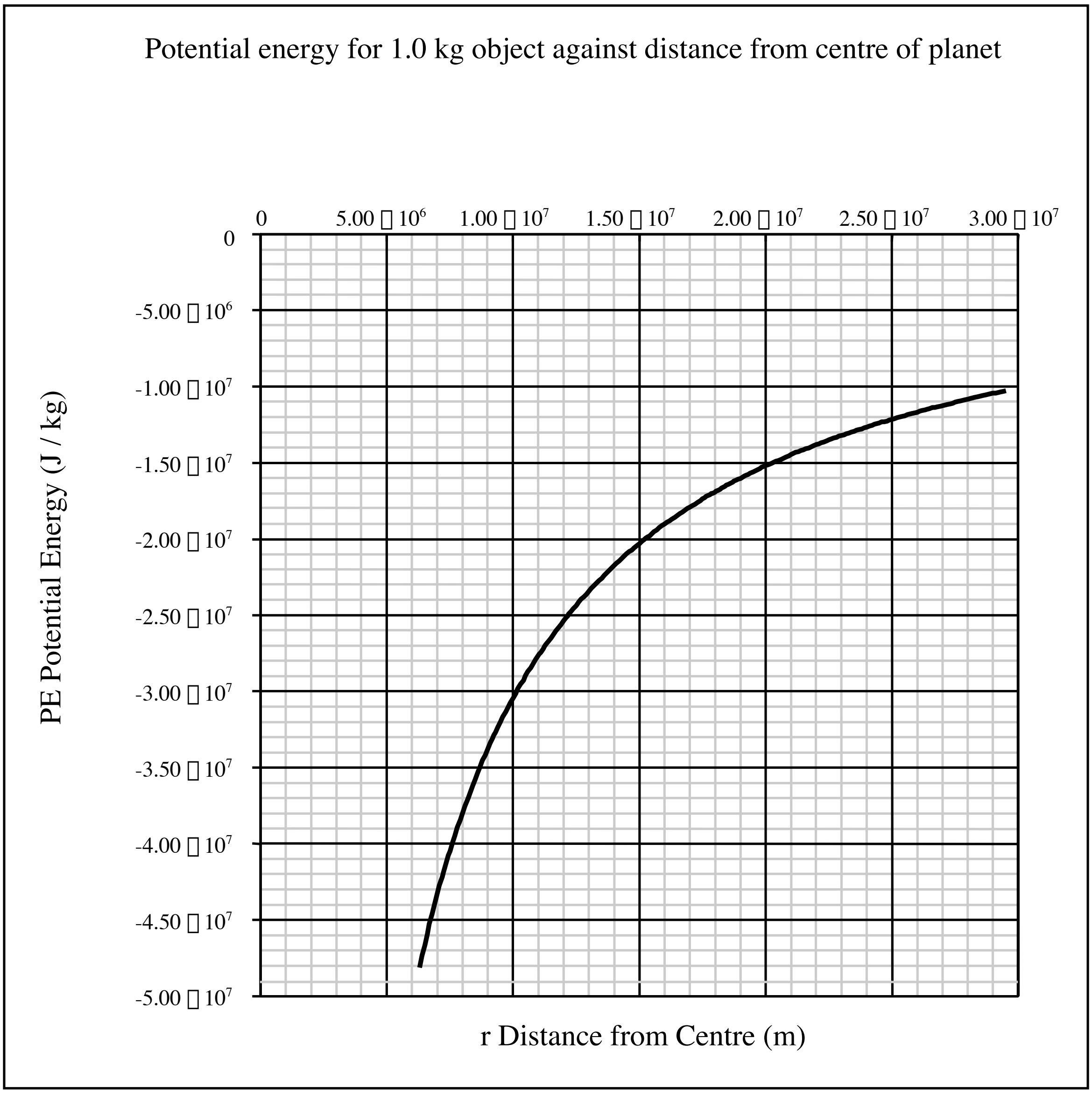
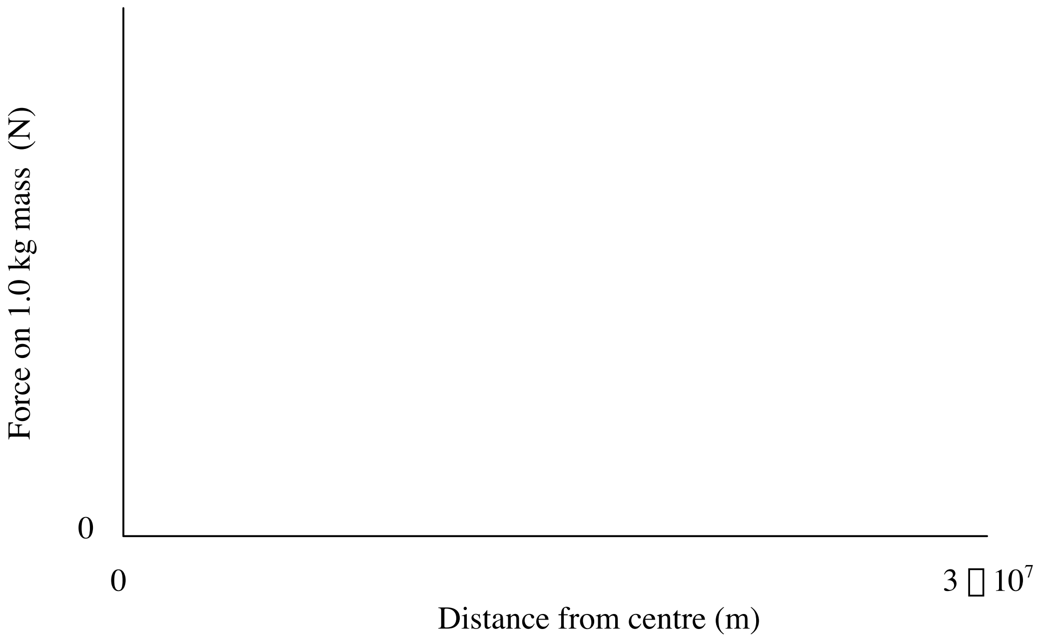


Question 2 continues opposite.

Question 2(continued)

(d) On the axes below, *sketch* a graph of **force** on a 1.0 kg mass against distance from planet. You should indicate at least one value of force on the vertical axis. (4 minutes)



(e) (i) A comet approaching the planet has a mass of 5.0×10^8 kg. What is its potential energy just before it reaches the surface of the planet (radius 6.4×10^6 m)? (3 minutes)

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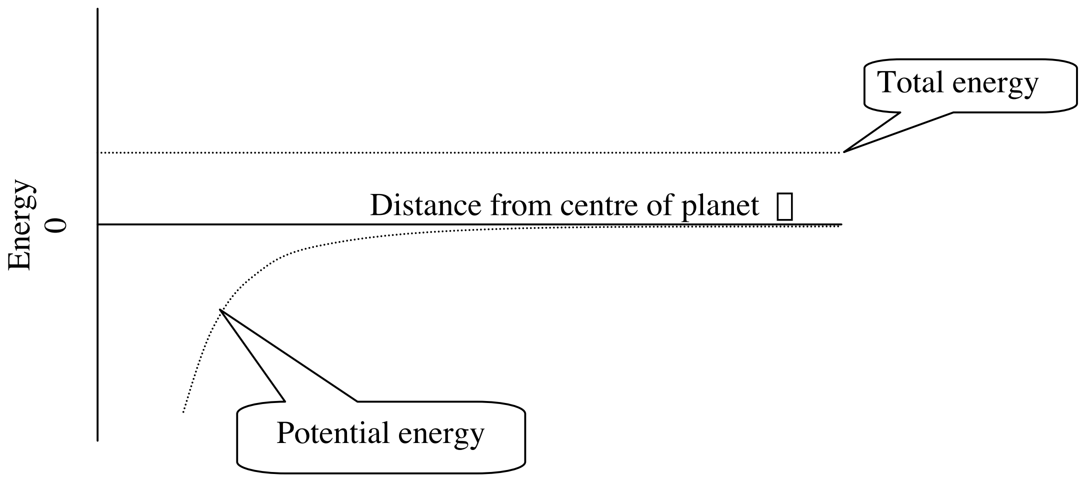
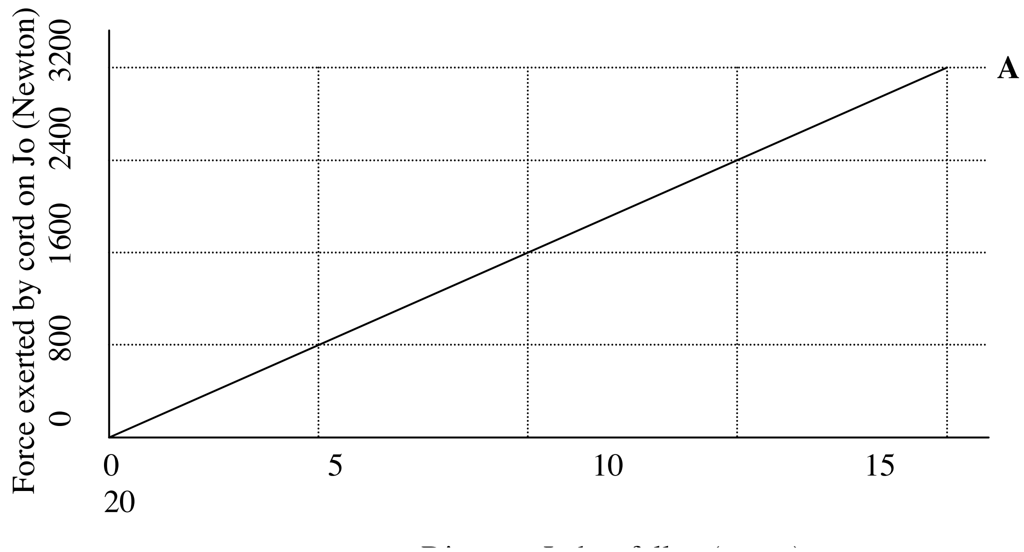
(ii) The graph below shows the total energy and the potential energy of the comet as it approaches the planet. If total energy = kinetic energy + potential energy, sketch a graph below of the **kinetic energy** against distance from the planet. (5 minutes)



SPARE DIAGRAMS FOR SECTION A

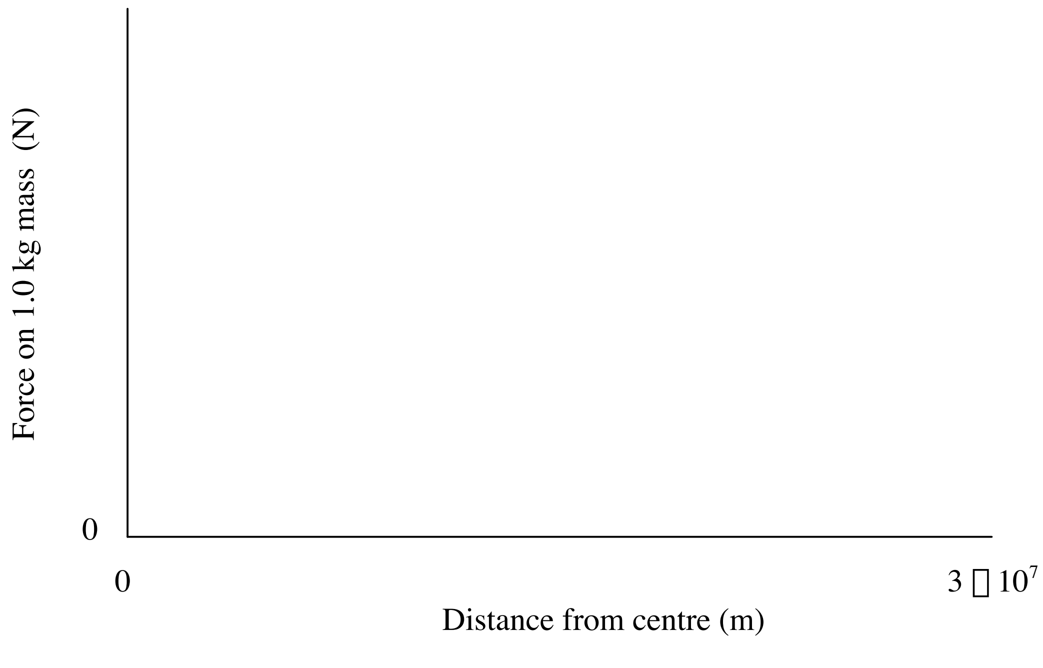
Question 1 (d)(i)



Question 2 (a)

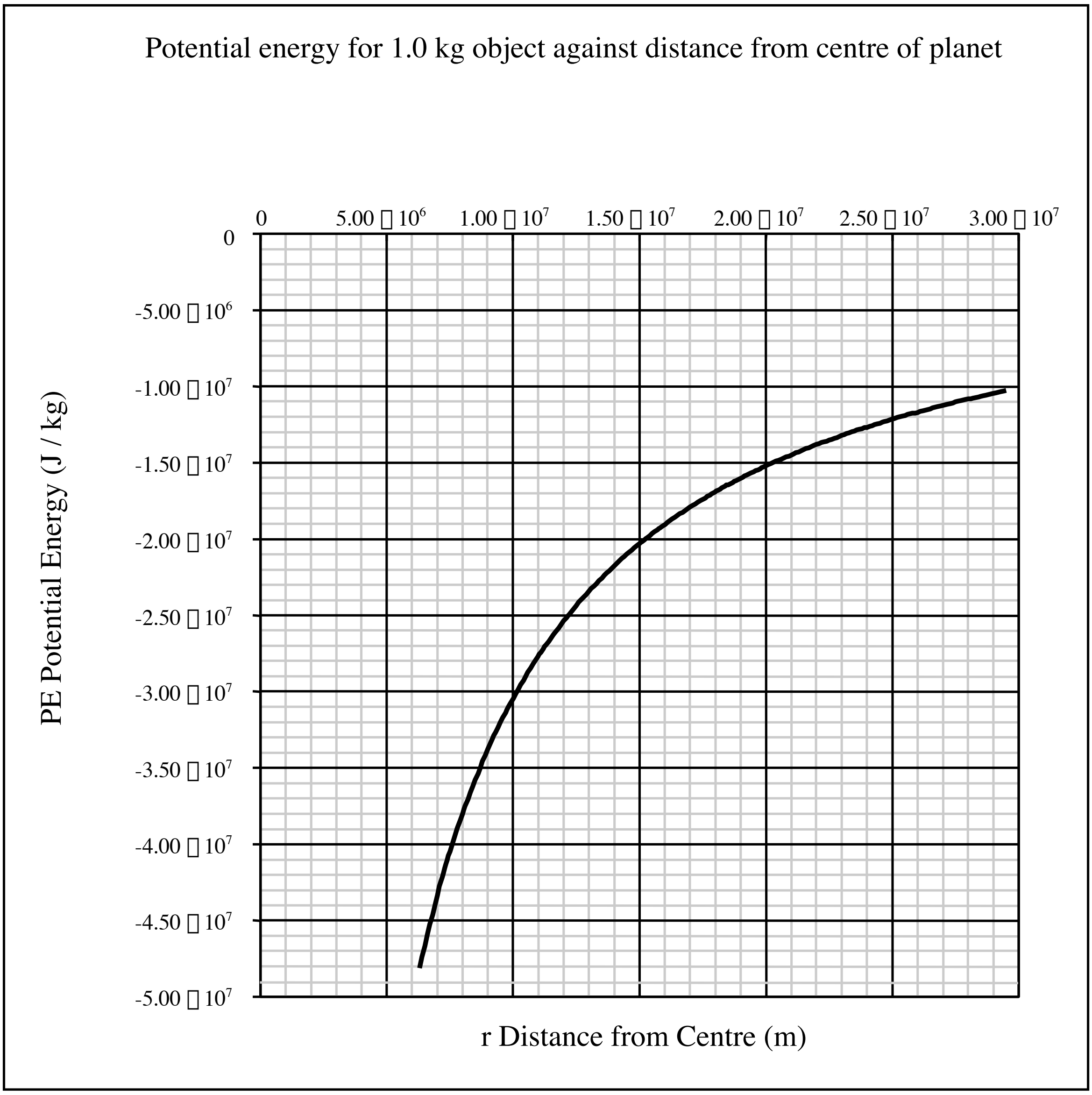
Potential Energy (10^7J)	-4.35	-3.86	-3.09	-2.47	-2.06	-1.54
Distance (10^6 m)	7.0	8.0	10.0	12.5	15.0	20.0

Question 2 (d)

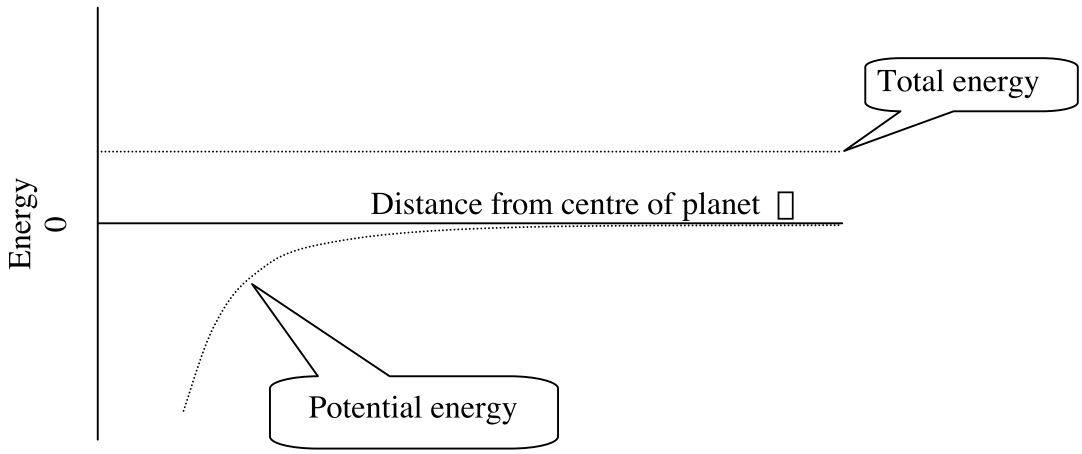


SPARE DIAGRAMS FOR SECTION A

Question 2 (c)



Question 2 (e)(ii)



FOR EXAMINERS USE ONLY

SECTION A

Question	Criterion 7
1	
2	

Criterion 2	

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Tasmanian Secondary Assessment Board

Tasmanian Certificate of Education

External Assessment

2002

PH866 PHYSICS

SECTION B

Time: 75 minutes

On the basis of your performance in this examination, the examiners will provide a rating of A, B, C or D on each of the following criteria taken from the syllabus statement:

Criterion 2 Convey information in a variety of ways using established conventions and appropriate language.

Criterion 10 Incorporate techniques of analysis and mathematical manipulation (algebraic, trigonometrical, numerical and graphical) to solve complex problems.

Pages: 16
Questions: 5

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CANDIDATE INSTRUCTIONS

Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

Recommended time:

Section B – 75 minutes.

The PH866 Physics Formula Sheet can be used throughout the examination.

No other printed material is allowed into the examination.

The following will be taken into account when determining your assessment on Criterion 2:

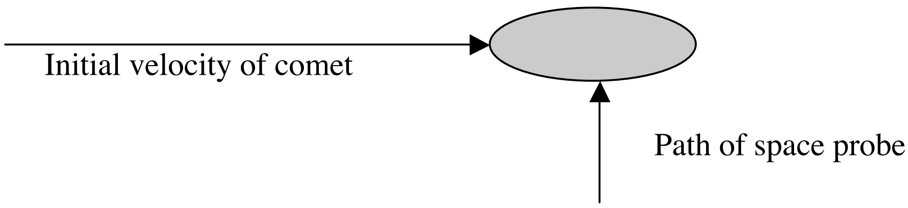
- numerical answers should have appropriate units and significant figures;
- vectors should have magnitude and direction;
- graphs should be in pencil and have appropriate scales, labelled axes, units, heading, clear point placement and a suitable line of best fit;
- diagrams should be used when appropriate (especially with vectors);
- answers should be clearly and logically explained.

A set of spare diagrams has been provided in the back of the answer booklet for you to use if required. If you use a spare diagram, please indicate you have done so in your answer to that question.

Question 3 (You should spend about 15 minutes in total on this question.)

(a) *A small comet or asteroid struck Siberia in 1908 causing an immense amount of damage in the region. Over the past few years scientists have been trying to detect such objects which are in danger of colliding with the earth. There has been much discussion on whether we should try to deflect or destroy such objects using explosive space probes.*

A comet of mass 5.0×10^{8} kg at a large distance from the earth approaches the earth. In order to deflect it off its path a space probe filled with explosives is sent to intercept the comet. The situation is shown in the diagram.



(i) The space probe has a mass of 4000 kg and is travelling with a velocity 3.0×10^{4} ms^{-1} perpendicular to the velocity of the comet when it hits the comet. If the probe comes to rest within the comet, what is the change in momentum of the comet and hence what is the change in velocity of the comet? (3 minutes)

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(ii) The probe now explodes, ejecting 5.0×10^{4} kg of material from the comet with a velocity relative to the comet of 1.0×10^{3} ms^{-1} in a direction exactly opposite the original probe velocity. Show that the **total** change in velocity of the comet due to the initial collision and the explosion is 0.34 ms^{-1}. (3 minutes)

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Question 3 continues opposite.

Question 3 (continued)

(iii) If the initial speed of the comet is 3.0×10^{4} ms^{-1}, show that the change in the *direction* of the velocity of the comet as the result of the above event (collision and explosion) is only 0.00065 degrees. (3 minutes)

(b) A rockclimber of mass 80 kg slides ('abseils') ***down*** a vertical rope. Determine the force exerted by the rope on the rockclimber when the rockclimber is

(i) moving with a *constant* speed of 20 metres per minute; (2 minutes)

(ii) reducing speed at the rate 2.0 ms^{-2}. (4 minutes)

Question 4 (You should spend about 15 minutes in total on this question.)

(a) A clothes line is made from a rope strung between two fixed supports 10.0 m apart. It is observed to oscillate with a fundamental frequency of 2.0 Hz.

(i) What are the frequencies of the next ***three*** harmonics. (2 minutes)

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(ii) Show that the velocity of the transverse wave in the rope is 40.0 ms^{-1}. (2 minutes)

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(iii) If the clothes line has a measured mass per unit length of 20 gm^{-1} what is the *tension* in the clothes line? (2 minutes)

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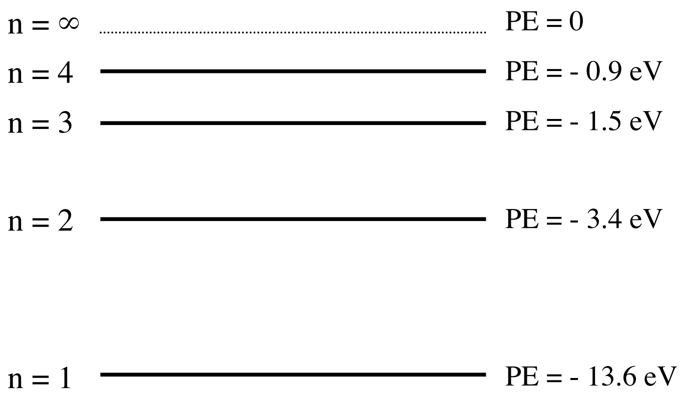
Question 4 continues opposite.

Question 4 (continued)

(b) The following diagram shows the first four energy levels within a neutral hydrogen atom and the outermost 'energy level'.



The hydrogen atom is bombarded with electrons of energy 12.5 eV.

(i) Assuming that the atom was initially in the ground state, list the energies of the *photons* that could be subsequently emitted by the excited hydrogen atom. (2 minutes)

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(ii) *Draw* the electron transitions responsible for these photons on the diagram. (2 minutes)

The ground state hydrogen atom is bombarded by 12.5 eV electrons. With what energy will these electrons bounce off if the collision is:

(iii) elastic

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inelastic

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(5 minutes)

Question 5 (You should spend about 15 minutes in total on this question.)

Black holes are 'objects' formed when a large amount of matter is compressed into a very small volume. For example, if the earth (mass 6.0×10^{24} kg) was compressed into a volume less than that of a small pebble it would form a black hole. The very rapid orbital motion of stars near the centres of some galaxies suggests that they are orbiting very large black holes.

(a) A star orbits a black hole in a circular orbit of radius of 3.0×10^{15} m and velocity 8.0×10^{5} ms^{-1}.

(i) What is the *acceleration* of the star in its orbit? (2 minutes)

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(ii) Hence show that the *mass* of the black hole at the centre of the orbit is 2.9×10^{37} kg. *(NB: This is the mass of over a million typical stars.)* (3 minutes)

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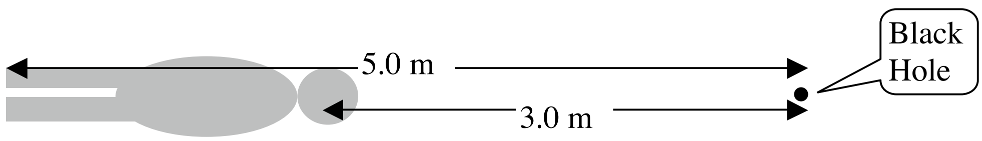
(b) You might like to imagine your examiner falling into an earth-mass (6.0×10^{24} kg) black hole as shown in the diagram.



(i) What is the gravitational field strength at your examiners head (3.0 m from the black hole)? (2 minutes)

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Question 5 continues opposite.

Question 5 (continued)

(ii) What is the gravitational field strength at your examiners feet (5.0 m from the black hole)? (2 minutes)

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(iii) Based on your calculations, what is likely to happen to your examiner while he is approaching the black hole? Explain your reasoning – a good answer will discuss the *acceleration* of the head and feet of the examiner.

(Hint: Astronomers sometimes refer to this process as ‘spaghettification’.) (2 minutes)

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(c) After walking across a nylon carpet, your examiner experienced a painful spark jump between his hand and a metallic door handle when his hand was 2.0 cm from the handle. A spark will jump through air if there is an electric field greater than 16 kV cm^{-1} present.

(i) What was the *potential difference* between the examiner and the door handle? (2 minutes)

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(ii) If the total charge which travelled between the door handle and the examiner was 2.0 □C, what was the total *energy* in the spark if the voltage was constant? (2 minutes)

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Question 6 (You should spend about 15 minutes in total on this question.)

(a) A *linear accelerator* at the Royal Hobart Hospital imparts an energy of 18 MeV to electrons which then crash into a tungsten target.

(i) What is the energy of the electron in Joules? (1 minute)

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(ii) What is the minimum wavelength of the X-rays produced? (2 minutes)

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(b) A doctor wishes to inject a patient with a dose of the radioactive isotope technetium-99. Technetium-99 has a half-life of 6.0 hours. The initial dose received by the patient is 1 GBq.

(i) What is the activity of the technetium-99 remaining after 1 day (24 hours)? (2 minutes)

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(ii) To prepare the technetium-99, the doctor obtains a sample of molybdenum ${}_{42}Mo^{99}$ from the nuclear reactor at Lucas Heights near Sydney. This slowly decays into technetium-99 ${}_{43}Tc^{99}$ which can be washed out of the molybdenum. Write out the nuclear equation showing the decay of molybdenum to produce technetium. (1 minute)

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(iii) If the sample of technetium-99 is prepared in the laboratory 3 hours before it is injected into the patient, what must be the activity of the technetium-99 just after it is prepared? (3 minutes)

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Question 6 continues opposite.

Question 6 (continued)

(c) The heat generated by high level radioactive waste gives rise to problems in disposing of this waste. To get an idea of the energy involved consider the energy produced in a lump of plutonium-239. The relevant data for the radioactive decay of ${}_{94}Pu^{239}$ is as follows:

Radioactive decay equation:	${}_{94}Pu^{239} \rightarrow {}_{92}U^{235} + {}_{2}He^{4}$	
Atomic masses	${}_{94}Pu^{239}$	239.0522 amu
	${}_{92}U^{235}$	235.0439 amu
	${}_{2}He^{4}$	4.00260 amu

Note: 1 amu = 1.66×10^{-27}kg

(i) Determine the energy produced in the radioactive decay of one atom of plutonium-239. (2 minutes)

(ii) Show that the number of atoms in **100.0 gram** of plutonium-239 is 2.52×10^{23}. (2 minutes)

(iii) The half life of plutonium-239 is 7.70×10^{11} seconds. Determine the number of radioactive decays that occur in 100.0 g of plutonium-239 in one second. (2 minutes)

Question 7 (You should spend about 15 minutes in total on this question.)

The proposed Basslink power cable will carry a high voltage electric direct current across Bass Strait from north to south. Two alternative techniques were considered for the return current to complete the circuit:

- *A 'monopole system' in which the current returns through the sea water;*
- *A metallic return system in which the current returns through a second copper cable laid along side the first.*

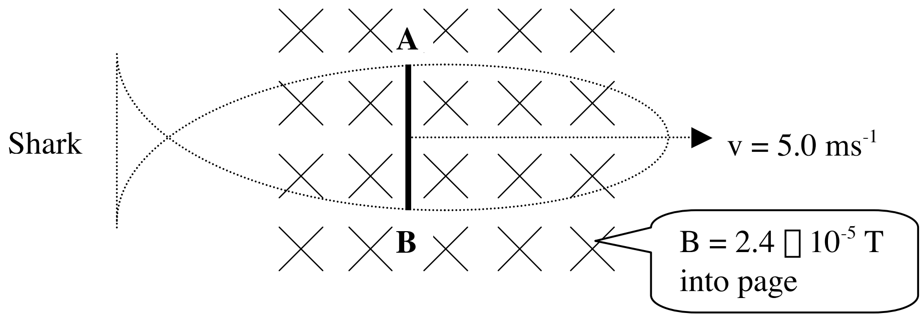
The magnetic field produced by the cable in the monopole system is much stronger than that produced by the metallic return system and can significantly deflect compass needles in ships travelling above the cable. The magnetic field may also induce electric *fields in sharks swimming nearby (sharks can detect electric fields of* $1\ \mu V m^{-1}$*).*

(a) An electric current of 1200 A flows in a cable from north to south.

(i) Show that the magnetic field at a position 10 m *above* the current has magnitude 2.4×10^{-5} T. What will be the direction of this magnetic field? (3 minutes)

(ii) The horizontal component of the earth's magnetic field is 61 μT north. What is the direction of the resultant magnetic field 10 m above the 1200 A current? (3 minutes)

(iii) A shark moves at 5.0 ms^{-1} through the magnetic field produced by the cable. Since animals are quite good conductors of electricity, the shark can be treated as a conductor AB of length 0.5 m moving through a magnetic field as shown in the diagram.



What emf is induced across the shark (conductor AB)? On the diagram label the *positive* end of the conductor AB. (2 minutes)

Question 7 continues opposite.

Question 7 (continued)

(iv) This voltage induced across AB sets up an *electric* field within the shark. Show that the *electric* field strength is 1.2×10^{-4} Vm^{-1}. (2 minutes)

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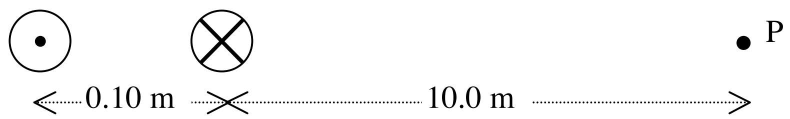
(b) Two cables separated by a distance of 0.10 m carry currents of 1200 A from north to south and from south to north respectively.

(i)



View of cables looking north in a horizontal plane (not to scale).

What is the magnitude of the total magnetic field strength at a position 'P' which is 10 m from the nearer cable as shown in the above diagram? (3 minutes)

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(ii) What will be the horizontal component of the magnetic field *directly above* the midpoint between the two cables. (No calculation is required, but give a reason for your answer.) (2 minutes)

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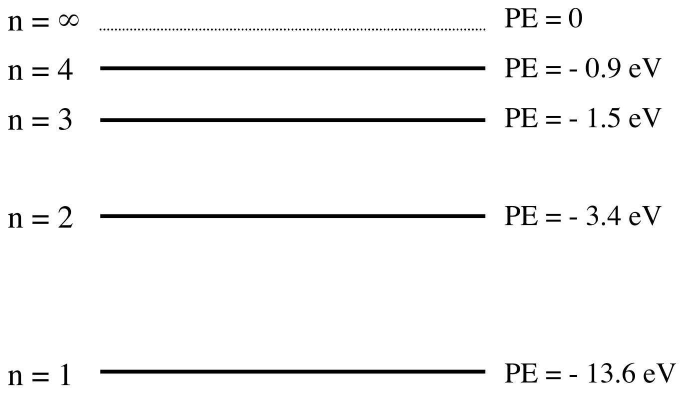
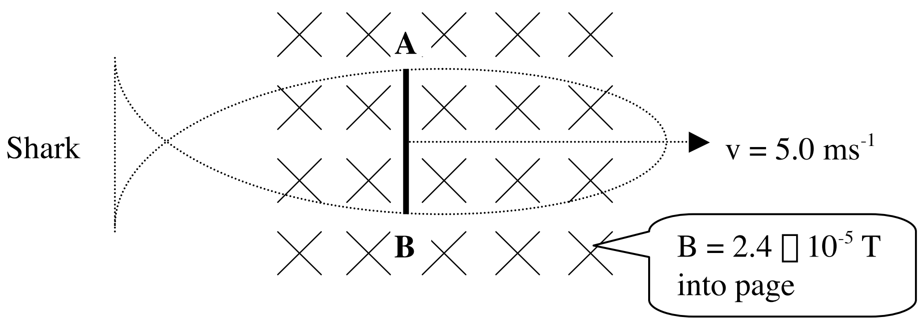
SPARE DIAGRAMS FOR SECTION B

Question 4 (b)



Question 7 (a)(iii)



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FOR EXAMINERS USE ONLY

SECTION B

Question	Criterion 10
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4	
5	
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7	

Criterion 2	

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2002

PH866 PHYSICS

SECTION C

Time: 60 minutes

On the basis of your performance in this examination, the examiners will provide a rating of A, B, C or D on each of the following criteria taken from the syllabus statement:

Criterion 2	Convey information in a variety of ways using established conventions and appropriate language.
Criterion 9	Demonstrate and apply knowledge and understanding of terminology; definitions and laws; concepts, theories and models; and uses of measuring instruments of Physics.

Pages: 16
Questions: 3

CANDIDATE INSTRUCTIONS

Answer **ALL** questions, **except** for **Question 10** (see below). Answers must be written in the spaces provided on the examination paper.

Recommended time: Section C – 60 minutes.

NOTE:

Candidates have a choice in Question 9. Answer THREE of the four parts.

Candidates have a choice in Question 10. Answer parts (a), (b), (c), (d), (e) and (f) OR (g) and (h).

The PH866 Physics Formula Sheet can be used throughout the examination.

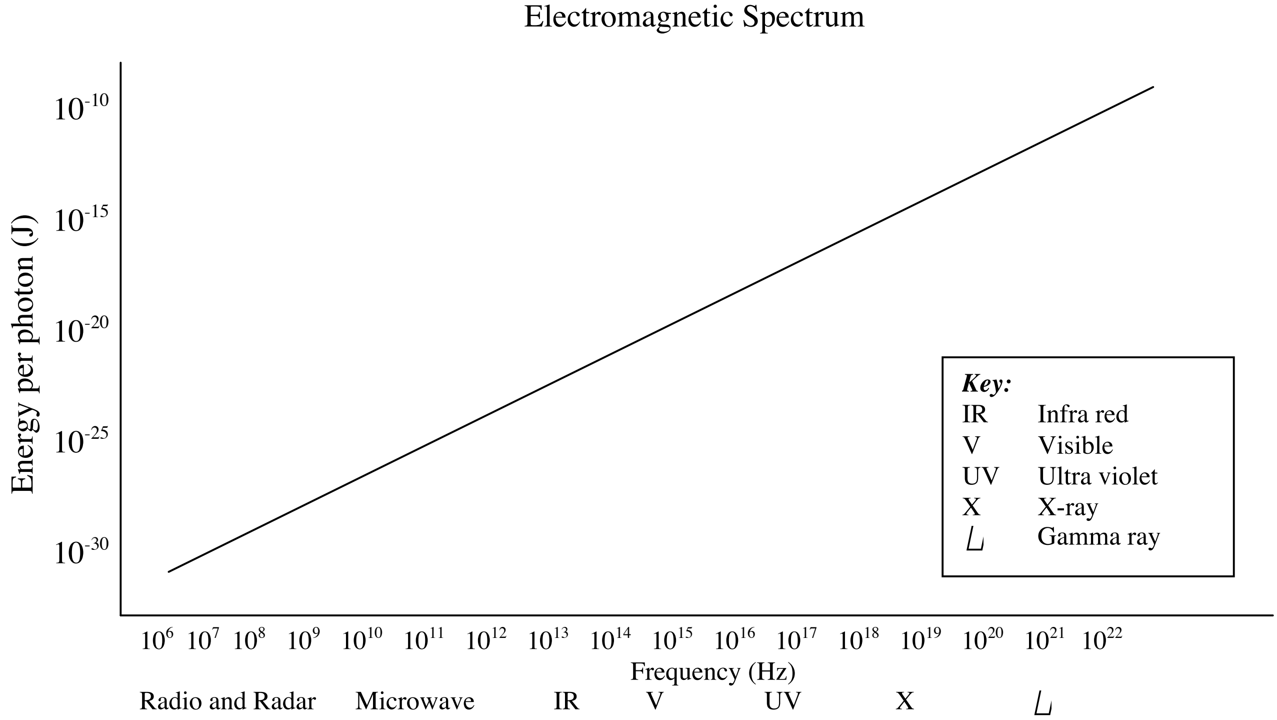
No other printed material is allowed into the examination.

The following will be taken into account when determining your assessment on Criterion 2:
- numerical answers should have appropriate units and significant figures;
- vectors should have magnitude and direction;
- graphs should be in pencil and have appropriate scales, labelled axes, units, heading, clear point placement and a suitable line of best fit;
- diagrams should be used when appropriate (especially with vectors);
- answers should be clearly and logically explained.

A set of spare diagrams has been provided in the back of the answer booklet for you to use if required. If you use a spare diagram, please indicate you have done so in your answer to that question.

Question 8 (You should spend about 15 minutes in total on this question.)

The diagram below shows some properties of the various types of electromagnetic radiation. **Be sure to give an explanation in answering each of the following questions.** It may help you to refer to the information provided by the graph in giving your explanations.



Question 8 continues opposite.

Question 8 (continued)

(a) Does the 'blackbody' radiation emitted by very hot objects have a higher or lower average frequency than that emitted by cooler objects? (2 minutes)

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(b) Of the various categories of radiation, which are most able to ionise atoms? (2 minutes)

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(c) Why do nuclear reactions tend to emit gamma rays whereas reactions involving the outer electrons of atoms tend to emit lower frequency waves such as light waves? (3 minutes)

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(d) An 'Electrically Programmable UV Erasable Read Only Memory' (EPROM) is a computer memory chip which operates as follows:

- to store memory in the chip, electrons are injected into the memory region of the chip;
- to erase memory from the chip, the chip is irradiated with ultra violet light which removes the electrons from the memory area .

The specifications for an EPROM state that 'wavelengths of light less than 400 nm begin to erase memories. The recommended wavelength for erasure is 250 nm.'

Explain why short wavelengths are necessary to bring about erasure. Your answer may include a mention of the 'photoelectric effect'. (4 minutes)

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(e) Ultra violet light from the sun is broadly divided into two categories: type 'A' has a mean *wavelength* of 320 nm to 400 nm while type 'B' has a mean *wavelength* of 280 nm to 320 nm. Which of these two forms of UV is more likely to cause damage to human skin? (4 minutes)

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Question 9 (You should spend about 30 minutes in total on this question.)

Answer THREE of the four parts to this question.

During the past year or more there has been considerable controversy over the rebuilding of Australia's only nuclear reactor at Lucas Heights near Sydney. One use of the reactor has been in the production of radioactive isotopes for medical and industrial use in Australia.

(a) A typical reaction in a nuclear reactor is: ${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3{}_{0}n^{1}$.

(i) Why is this described as a *fission* reaction? (1 minute)

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(ii) What is the importance of the fact that there are more neutrons on the right hand side of the equation than there are on the left hand side? (2 minutes)

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(iii) In *diagnostic* medicine, a radioactive isotope is placed inside a person's body. The radiation emitted by this isotope is observed from *outside* the person's body in order to detect problems within the body. Conditions for a isotope to be suitable for this function include:

1. it should have a short half life
2. it should emit γ (gamma) rays but *not* α (alpha) or β (beta) rays.

Explain why both these conditions are necessary for the safety of the person receiving the radioisotope. (4 minutes)

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2. ....

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(iv) A nuclear reactor produces many radioisotopes which have no medical or industrial use and which emit β and γ radiation of high energy with half lives ranging from seconds to thousands of years. What problems are likely to arise when disposing of these unwanted radioisotopes? (3 minutes)

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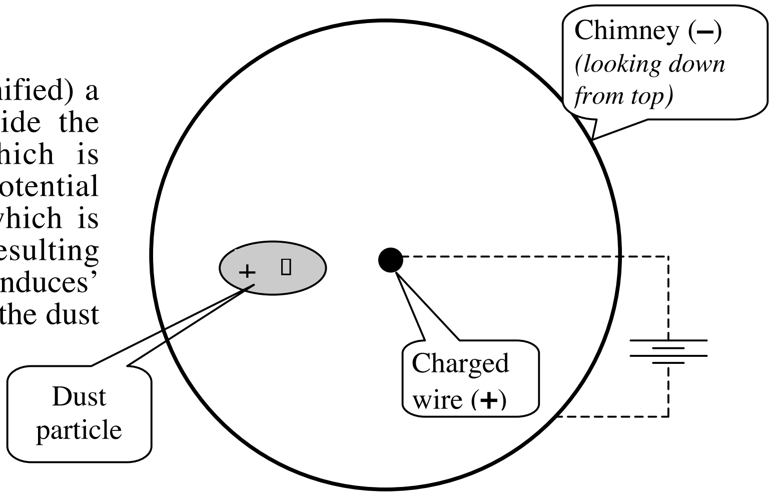
Question 9 continues opposite.

Question 9 (continued)

(b) The diagram shows (greatly magnified) a dust particle in a chimney. Inside the chimney is a central wire which is maintained at a high positive potential relative to the chimney itself (which is connected to the earth). The resulting electric field within the chimney 'induces' equal and opposite charges within the dust particle as shown.



(i) On the diagram, sketch the lines of the electric field between the central wire and the chimney walls. (1 minute)

(ii) From your diagram, explain why the *negative* end of the dust particle experiences greater field strength than the *positive* end. (3 minutes)

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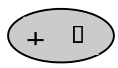
(iii) In the diagram alongside sketch to scale the forces acting on the positive and the negative ends of the dust particle and using your diagram explain why the dust particle moves towards the central wire. (3 minutes)



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(iv) When the dust particle touches the central wire it acquires a net positive charge. In which direction will the dust particle now move? Explain your answer. (3 minutes)

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Question 9 continues over the page.

Question 9 (continued)

(c) (i) What is meant by saying that sound travelling through the air is a *longitudinal* wave? (2 minutes)

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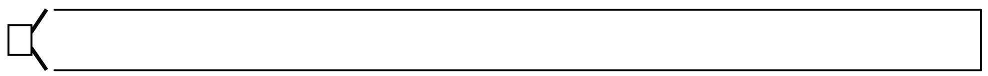
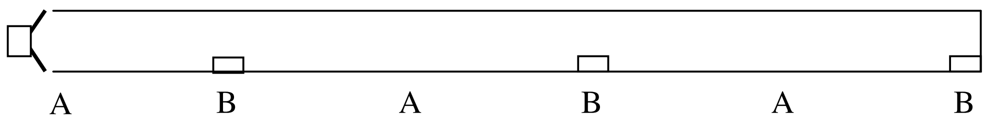
(ii) In the following experimental apparatus a loudspeaker is placed near the open end of a glass tube which is closed at the other end. Sketch the wave pattern for *one* of the possible standing waves in the tube. Label *nodes* and *antinodes* on the diagram.(2 minutes)



(iii) A very fine powder is placed in the tube. At a particular frequency (corresponding to one of the resonance frequencies of the tube) the grains of powder are observed to oscillate rapidly in some parts of the tube (labelled 'A' on the diagram) and to remain at rest in other parts of the tube (labelled 'B' on the diagram). Eventually, all of the powder comes to rest at the points marked 'B' as shown.



On the diagram sketch the standing wave that is present within the tube in this case. (1 minute)

(iv) In the above situation, explain why the grains of powder behave as they do at the points 'A' and 'B'. (2 minutes)

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(v) Assuming the frequency of the loudspeaker is known, how could this experiment be used to measure the speed of sound in air? (3 minutes)

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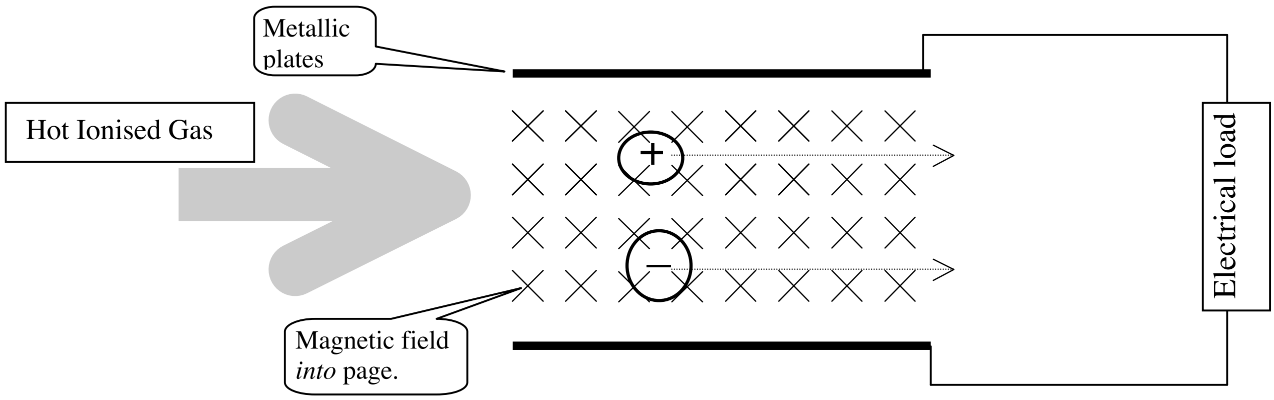
Question 9 continues opposite.

Question 9 (continued)

(d) *This question illustrates the principles of 'magnetohydrodynamic' power generation which, if technical problems can be sorted out, would be much more efficient than power generation in conventional turbines.*

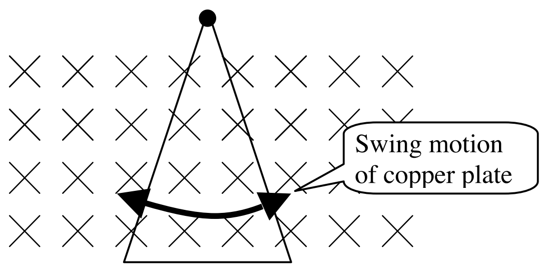
A mixture of positive and negative ions (from a very hot flame) is fired at high velocity into a magnetic field as shown. The magnetic forces on these ions cause them to move to metallic plates at either side of the magnetic field, charging the plates positively and negatively respectively. The charge then flows through an external circuit delivering electrical power to the electrical load.



(i) On the diagram above sketch the following: (5 minutes)

- Vectors showing the *forces* acting on the positive and negative ions;
- The sign of the electric *charge* that is developed on each plate;
- The direction of the *conventional current* that flows through the external circuit and the electrical load;
- A current carrying coil that would be suitable for generating the magnetic field shown, together with an arrow indicating the direction of the current around the coil.

(ii) A copper plate which can swing backwards and forwards like a pendulum is suspended within a magnetic field as shown. When the copper plate is *stationary* there is no magnetic force acting on the plate. However, when it is set *swinging* it experiences a magnetic force which opposes its motion and brings it to rest. Explain why this happens. (5 minutes)



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Question 10 (You should spend about 15 minutes in total on this question.)

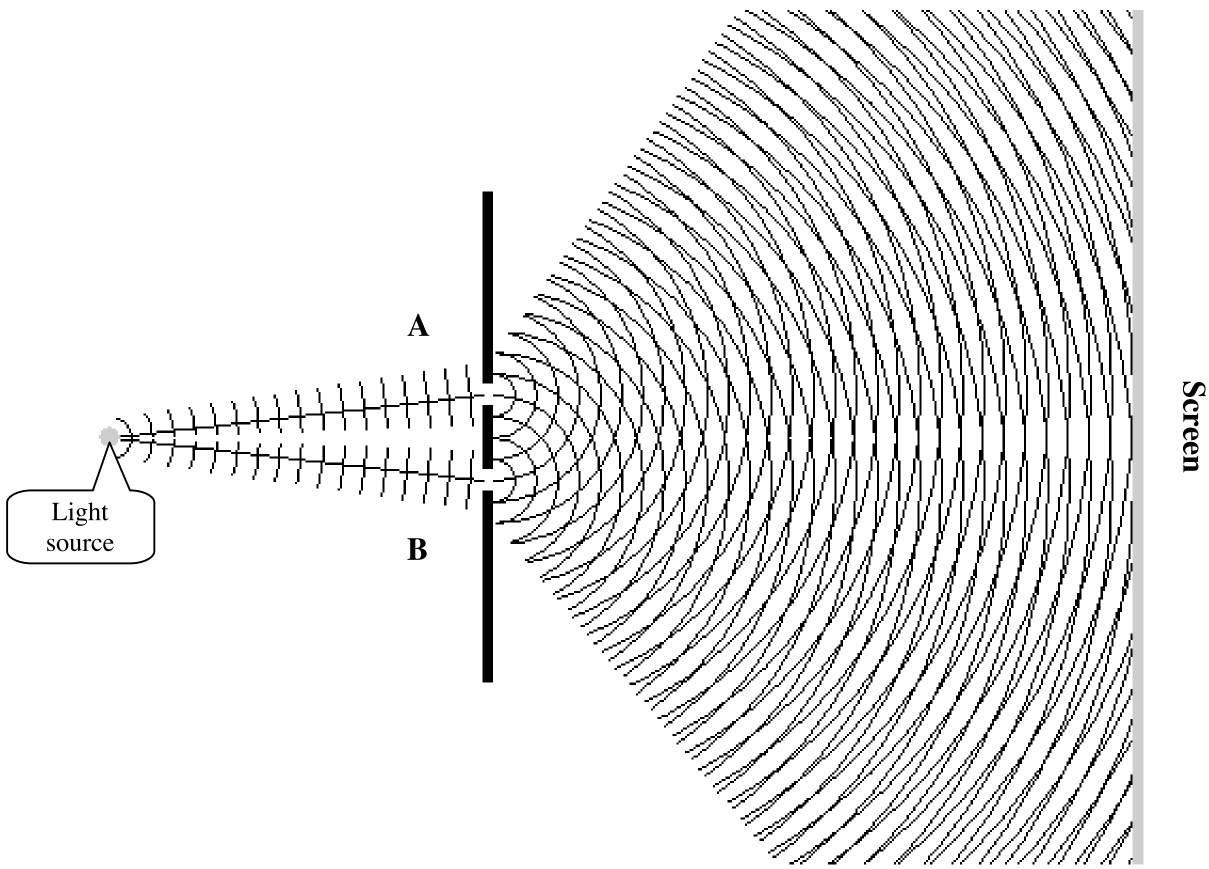
Answer EITHER parts (a), (b), (c), (d), (e) and (f)

OR parts (g) and (h)

of this question.

(a) The diagram below shows wavefronts for two beams of light which leave a light source and travel through two narrow slits A and B. On emerging from the slits the two beams of light travel towards a screen on which interference may be seen.

On the diagram below identify where on the screen there will be **bright** interference fringes.
(1 minute)



(b) Explain.

(i) Why there are **dark fringes** in between the bright fringes. (2 minutes)

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(ii) Why the narrow beams of light entering the slits from the left spread out into much broader beams when they emerge from the slits on the right. (2 minutes)

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Question 10 continues opposite.

Question 10 (continued)

(c) Using mirrors, fibre optics or other such devices Physicists can increase the path length from the light source to slit A while leaving the path length to slit B unchanged. Explain what will happen to the fringe pattern observed on the screen while the path length to A is gradually increased by one wavelength. (2 minutes)

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(d) The arrangement described in (c) can be set up to measure very small changes in the path length from the light source to slit B. Explain this.

(Hint: the **band width** of the fringe pattern on the screen can be made quite large (eg a few mm)). (2 minutes)

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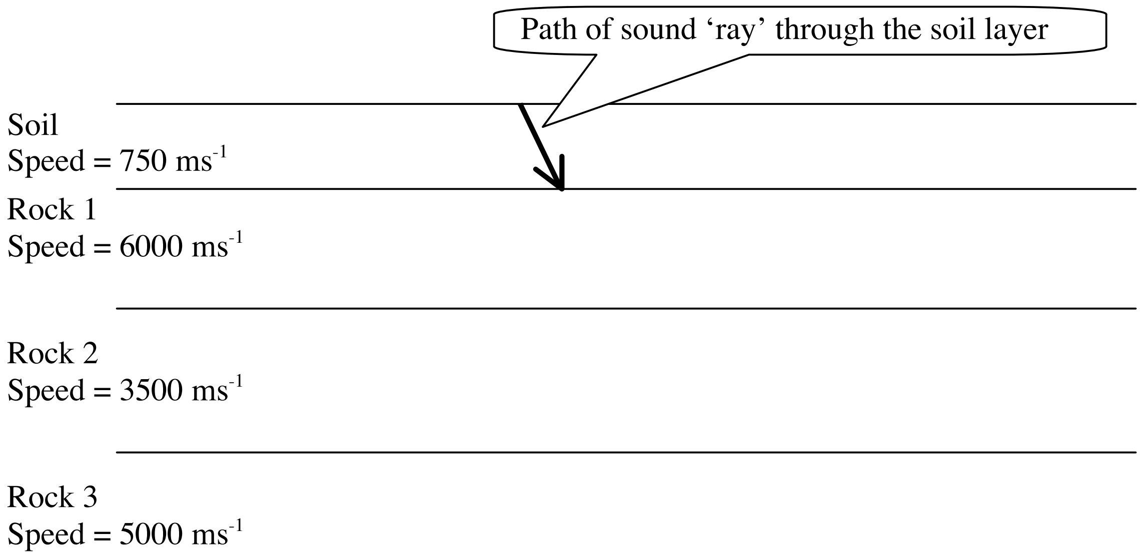
(e) The diagram below shows the different soil and rock layers which are typically found in Tasmania and the speed of sound in them. A small explosion sends a 'ray' of sound from the surface down through the various layers.

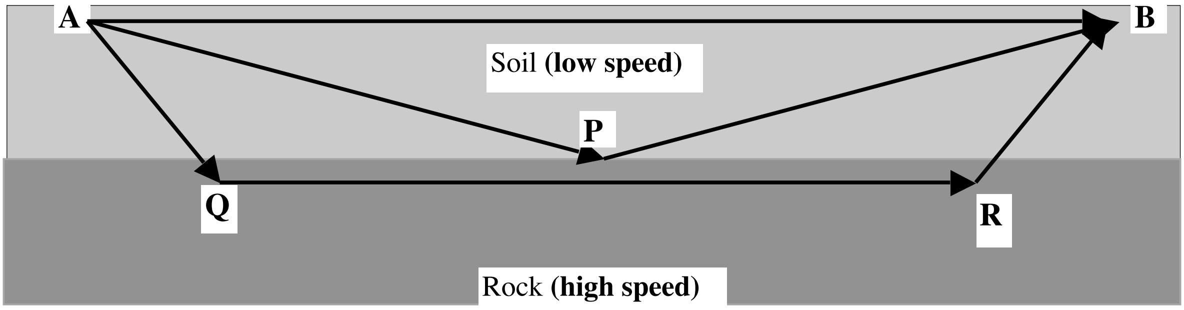
Complete the diagram to show the path of the sound 'ray' as it traverses the three Rock layers. (2 minutes)



Question 10 continues over the page.

Question 10 (continued)

(f) The diagram below shows a layer of soil in which sound travels at a low speed overlays a layer of rock in which sound travels at a high speed.



A short pulse of sound emitted by a small explosion at point ‘A’ on the surface can travel in three different ‘rays’ to a detector at point ‘B’ further along the surface. These are:

- the **direct** ray AB through the soil
- the **reflected** ray APB in which the sound ray is reflected off the boundary between the soil and rock
- the **refracted** ray AQRB in which the sound ray enters the rock at just below the critical angle, travels *within the rock* for a distance and then is refracted up to the detector.

(i) Which of the ‘direct’ and ‘reflected’ rays would reach the detector in the shortest time? Explain. (1 minute)

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(ii) When the distance AB is *small* the ‘direct’ wave reaches the detector in a shorter time than the ‘refracted’ wave. However, for *larger* distances AB the ‘refracted’ wave reaches the detector first. Explain what is happening. (3 minutes)

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Question 10 continues opposite.

Question 10 (continued)

OR

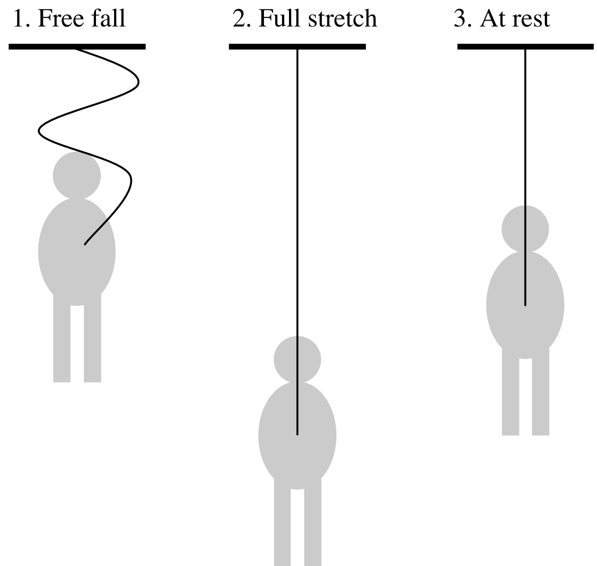
(g) Climbing ropes are designed to stretch by up to 50% of their length when supporting a falling rock climber.

(i) In the diagrams opposite show, to approximate scale, the forces acting on a rock climber who is attached to a climbing rope in the following three situations:

The rock climber is

1. falling freely with the climbing rope unstretched;
2. at the bottom of his fall with the climbing rope fully stretched;
3. at rest at the end of the partially stretched rope.

NB: You should use the same scale to draw your force vectors in ***all*** *three diagrams.* (3 minutes)



(ii) Explain, in terms of the physics involved, why a rope that *stretches* is safer for a falling rock climber than a rope which does *not* stretch. (2 minutes)

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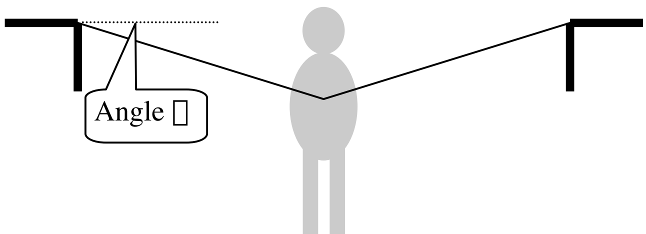
(iii) In a 'Tyrolean Traverse' a rock climber crosses a chasm suspended on a rope as shown in the diagram. Assuming that the tension is constant throughout the rope, sketch a vector triangle showing the forces acting on the climber. (2 minutes)



Question 10 continues over the page.

Question 10 (continued)

(iv) If the angle that the rope makes with the horizontal is very small the rope can break (even when the breaking strength of the rope is much greater than the weight of the climber). Use your vector diagram from part (iii) to explain how this can happen. (2 minutes)

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(h) (i) A comet approaches the earth as shown in the diagram (which is not to scale). Draw, *to scale*, vectors representing the gravitational forces exerted by the earth and the comet on each other. Label these vectors in the style ‘ force exerted by …….. on ……..’. (2 minutes)

(ii) If the comet crashes onto the earth, what happens to the

1. momentum of the comet (2 minutes)

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2. kinetic energy of the comet? (2 minutes)

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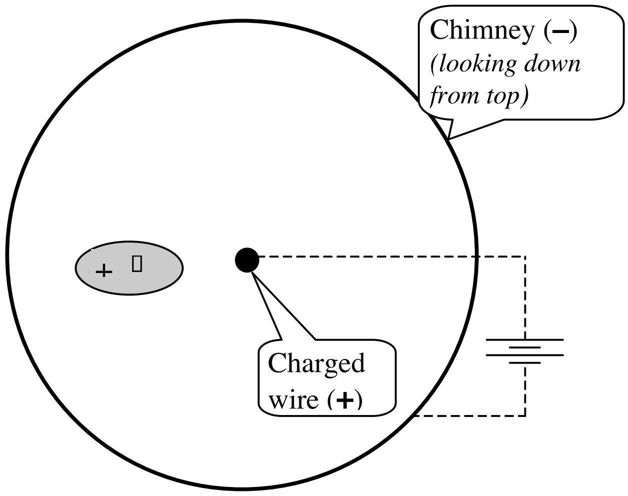
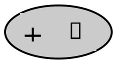
SPARE DIAGRAMS FOR SECTION C

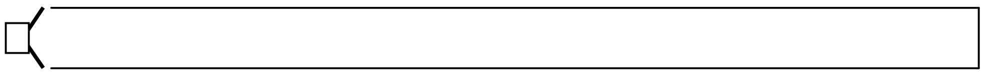
Question 9(b)(i)



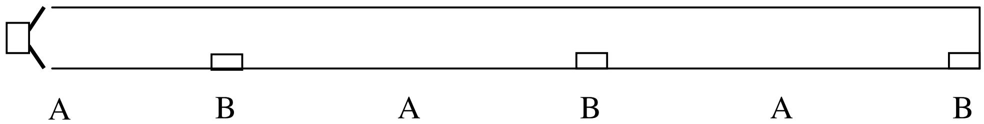
Question 9(b)(iii)



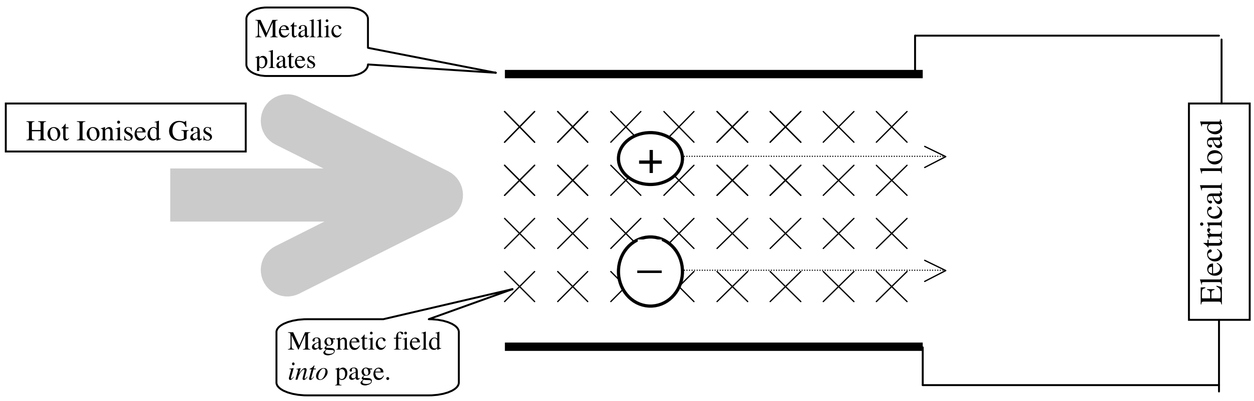
Question 9(c)(ii)



Question 9(c)(iii)

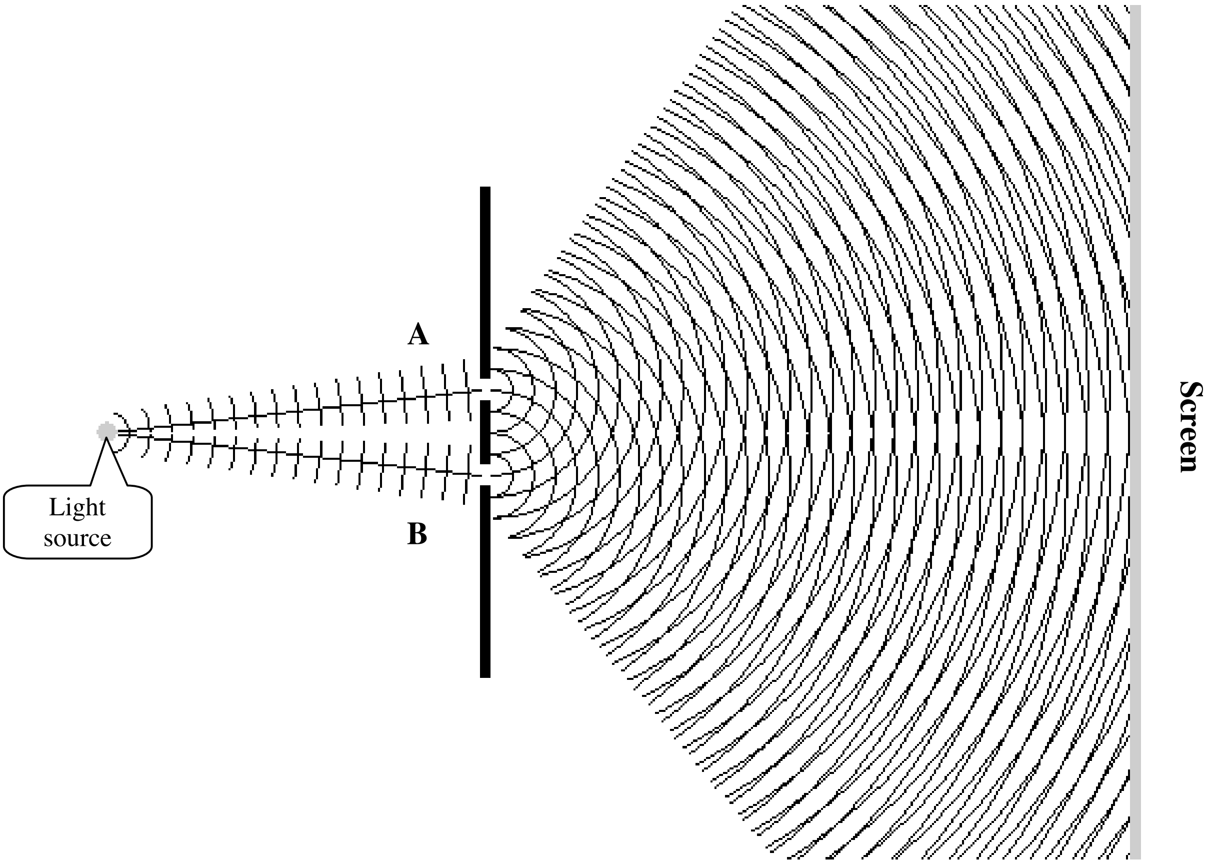


Question 9(d)(i)

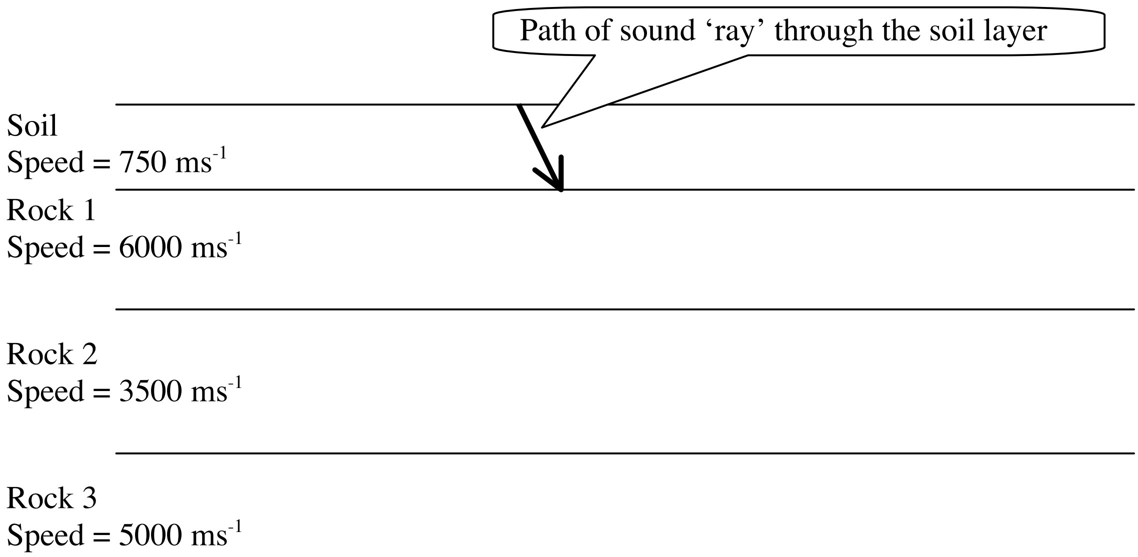


SPARE DIAGRAMS FOR SECTION C

Question 10(a)

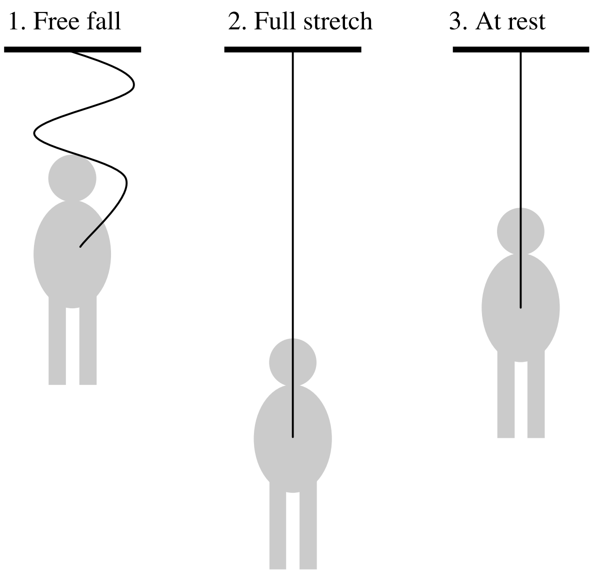


Question 10(e)

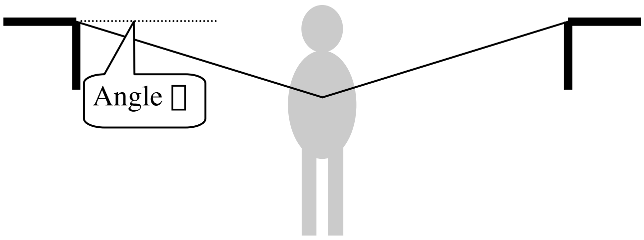


SPARE DIAGRAMS FOR SECTION C

Question 10(g)(i)



Question 10(g)(iii)



Question 10(h)(i)

FOR EXAMINERS USE ONLY

SECTION C

Question	Criterion 9
8	
9	
10(a)	
10(b)	
10(c)	
10(d)	
10(e)	
10(f)	
10(g)	
10(h)	

Criterion 2	