TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

External Assessment 2025

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PHYSICS

PHY415115

Section A Newtonian Physics

Pages: 12
Questions: 5
Information Sheet: 1

Preparation time for this exam: 15 minutes

Suggested working time: 45 minutes

Instructions:

- Answer **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
- A spare diagram has been provided at the end of this section. Indicate in the box provided if you have used the spare diagram.
- TASC-approved scientific calculators can be used throughout the exam.
- The Physics Information Sheet can be used throughout this exam.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 45 minutes**.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C5	/ 45

Guide to Exam Structure

	Questions available	Questions to answer	Suggested working time	Marks available
Section A	5	5	45 minutes	45 marks
Section B	6	6	45 minutes	45 marks
Section C	6	6	45 minutes	45 marks
Section D	6	6	45 minutes	45 marks
Totals	**23**	**23**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 5 identify and apply principles of Newtonian mechanics including gravitational fields.

Question 1

Marker use

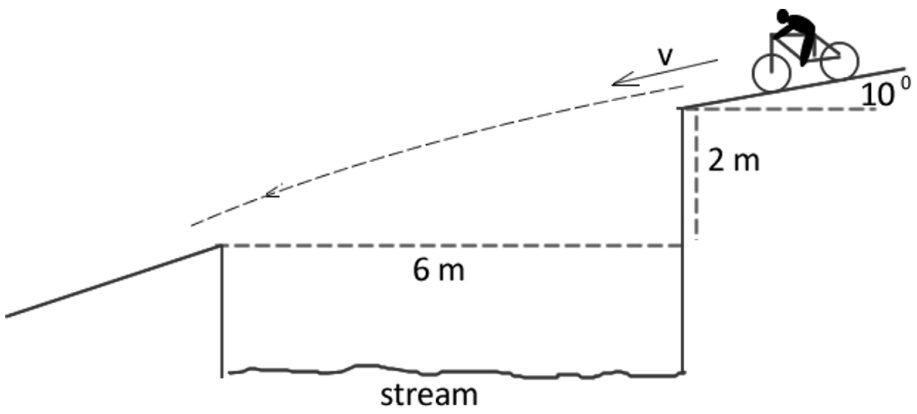

Figure 1

A mountain-bike stream crossing is shown in Figure 1.

The crossing is 6 m wide horizontally. Vertically the rider falls 2 m.

The start ramp is at –10° to the horizontal.

a) If the rider's speed is 52 km h^{-1} when leaving the ramp, calculate the components of the velocity.

i. Horizontally

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/1

ii. Vertically

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/1

b) Does the rider cross the river? Justify your answer.

/3

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Total Q1

/5

Question 2

Marker use

A hockey ball of mass 0.160 kg is travelling from left to right at 5.00 m s^{-1}. It is struck at an angle of 73.6^0 to the ball's initial motion with a force of 10.7 N for a duration of 0.110 s, as shown in Figure 2.

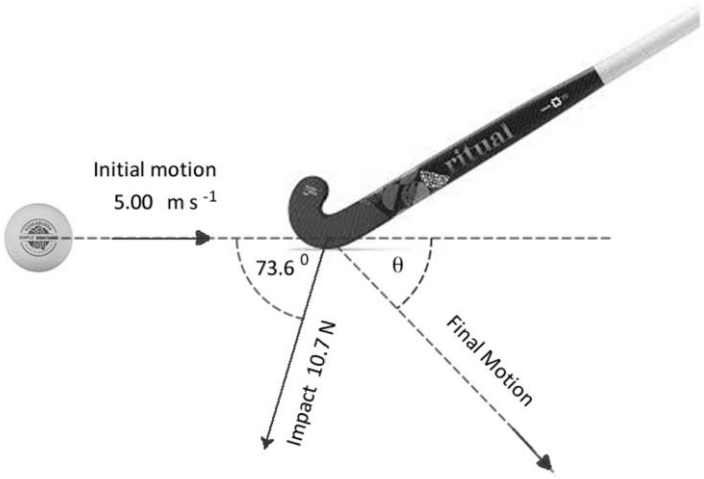

Figure 2

a) Show that the change of momentum of the ball has a **magnitude** of 1.18 kg m s^{-1}.

/1

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b) Draw a labelled vector diagram that will enable the final motion of the ball to be calculated.

/3

c) Calculate the final speed of the hockey ball.

/3

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Question 2 continues

Marker use

d) Calculate the deflection angle, θ, as shown in Figure 2.

/2

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Total Q2

/9

Question 3

Marker use

In 1665, Newton first thought about gravity at his home by comparing the falling of apples to the motion of the Moon.

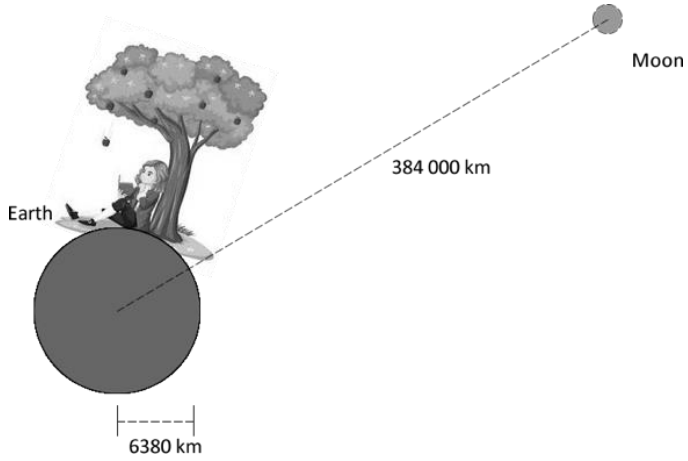

Figure 3

The Earth has a radius of 6 380 km while the Moon is 384 000 km from Earth's centre.

Objects fall at the surface of Earth at a rate of 9.81 m s^{-2}.

The Moon completes one orbit around Earth every 27 days and 8 hours.

a) Calculate the orbital speed of the Moon in m s^{-1} assuming a circular orbit.

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b) Calculate the magnitude of the centripetal acceleration of the Moon in its orbit.

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Question 3 continues

Marker use

c) From the results of part a) and b), show that gravity's acceleration follows an inverse square law.

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The International Space Station (ISS) is at a mean altitude of 420 km above the Earth's surface.

/2

d) Calculate the acceleration of ISS.

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Total Q3

/10

Question 4

Marker use

Two of the three stars in the Alpha Centauri star system are fairly close to each other. These are Alpha Centauri A and Alpha Centauri B, henceforward referred to as Star A and Star B.

Star A has a mass of 2.19×10^{30} kg while Star B has a mass of 1.79×10^{30} kg. They are separated by a distance of 3.00×10^{12} m on average.

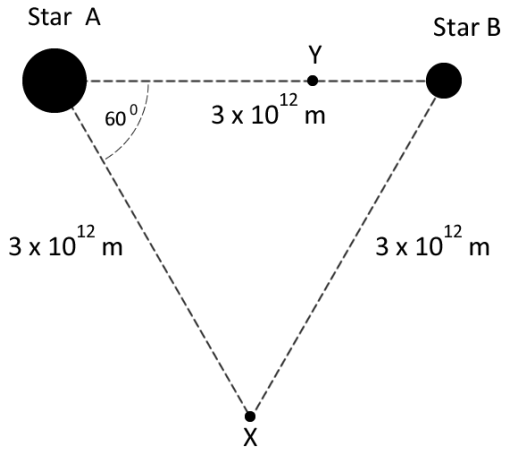

Figure 4

a) Point X forms an equilateral triangle with Star A and Star B.

i. Calculate the gravitational field strength of Star A, g_A at point X.

/2

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ii. Calculate the gravitational field strength of Star B, g_B at point X.

/2

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iii. Calculate the **magnitude** of the total gravitational field strength at point X.

/3

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Question 4 continues

Marker use

b) Calculate the distance from Star A to point Y from Figure 4, between the stars where the total gravitational field is zero.

/3

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c) Sketch the gravitational field around the two stars on Figure 5.

/2

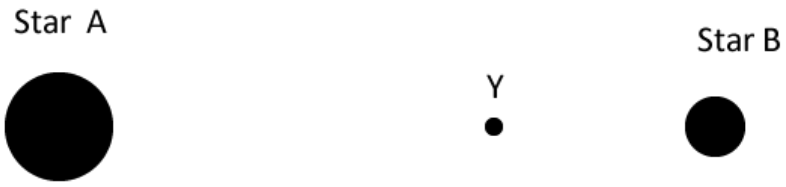

Figure 5

Spare diagram used (X) ☐

Total Q4

/12

Question 5

Marker use

A Blackhawk helicopter hovering in place generates a downward cylinder of air moving at an average speed of 18.0 m s^{-1}. The rotor blades are 8.20 m long.

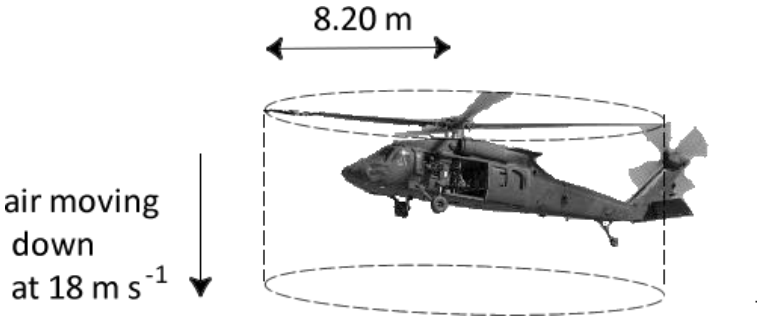

Figure 6

Consider a time period of 1 second, during this time stationary air is given momentum downwards.

a) We wish to calculate the change in momentum of this air per second.

i. Show that the volume of air driven down in 1 second is 3.80 x 10^3 m^3.

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ii. If the density of air is 1.29 kg m^{-3}, calculate the mass of this air.

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iii. Calculate the change of momentum of the air caused by the helicopter blades.

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b) Given the helicopter is stationary, calculate the mass of the helicopter.

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Question 5 continues

Question 5 continued

Marker use

c) While the helicopter is hovering, the engines are operating at 1800 kW. Calculate the percentage of the engines' power transferred to the air.

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Spare Diagrams

Question 4 c)

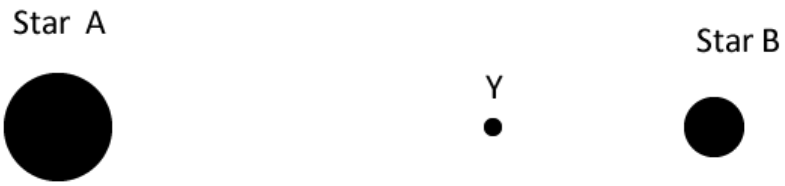

Figure 5

End of Section A

Total Q5

/9

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PHYSICS

PHY415115

Section B Electromagnetism

Pages: 16
Questions: 6
Information Sheet: 1

Suggested working time: 45 minutes

Instructions:

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Marker use	
C6	/ 45

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Guide to Exam Structure

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Section A	5	5	45 minutes	45 marks
Section B	6	6	45 minutes	45 marks
Section C	6	6	45 minutes	45 marks
Section D	6	6	45 minutes	45 marks
Totals	**23**	**23**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 6 identify and apply principles of electricity and magnetism.

Question 6

Marker use

Air is usually an insulator as the gases are covalent molecules. However, if a sufficiently strong electric field is applied, molecules can be ionised leading to lightning.

Consider a column of rising air from which a thunderstorm forms. The base of the thundercloud is usually negative.

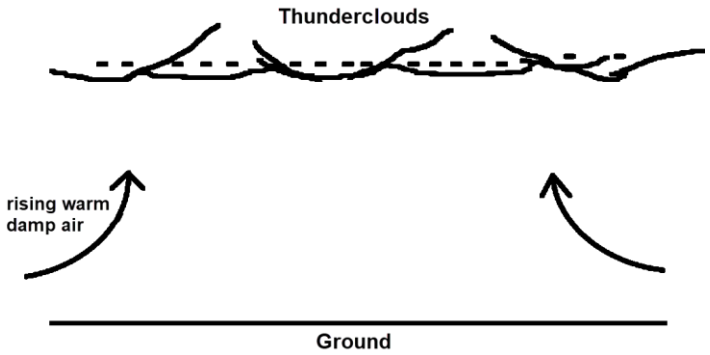

Figure 7

Spare diagram used (X) ☐

a) What charge will tend to form on the ground.

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b) Sketch the average electric field between the cloud and the ground on Figure 7. /1

The electric field strength at which air becomes ionised is between 2 to 3 MV m^{-1}. This value depends on moisture content and other variables.

c) Lightning tends to form from sharp points on the ground. Suggest why, using the Figure 8 diagram and the known ionising field strength. /2

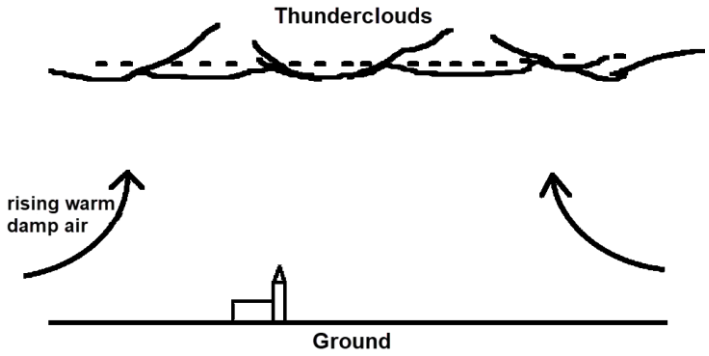

Figure 8

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Question 6 continues

Marker use

d) Why might a person's hair standing on end under a thundercloud be an indication of danger to the person?

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During a thunderstorm, a particular lightning strike travelled 5.0 km long cloud to ground. It lasted 20 milliseconds and carried an estimated current of 30 kA.

e) Calculate the minimum potential difference of the cloud relative to the ground.

/2

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f) Calculate the charge transferred.

/1

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g) Calculate the minimum energy released in the strike.

/2

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Total Q6

/10

Question 7

Marker use

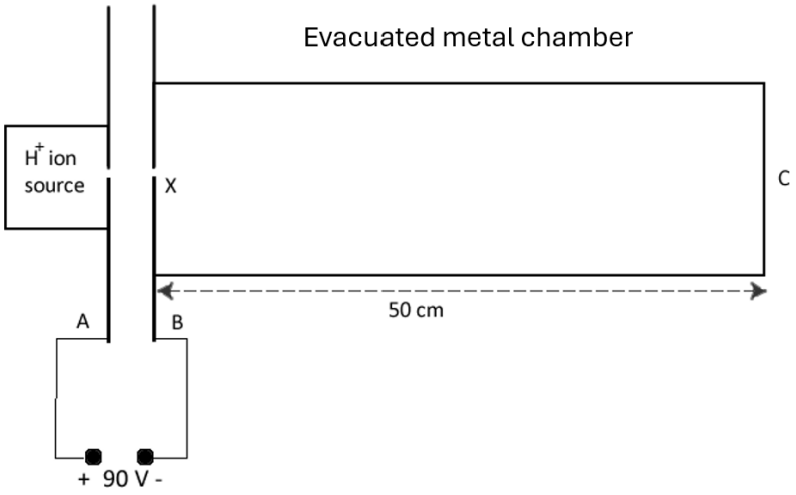

Figure 9

Positive H^+ ions are injected at a hole, X, into an evacuated metal chamber as shown in Figure 9 above.

90 V are placed across the plates A and B.

Holes at A and B allow the ions to freely move into the metal cylinder and arrive at C 50 cm from X.

a) Explain why acceleration occurs between A and B. /1

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b) Explain why no acceleration occurs between X and C. /2

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c) Calculate the kinetic energy in joules of an ion when entering at X. /2

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Question 7 continues

Marker use

A timing system is set up between X and C to measure the ion traverse time.

d) If an ion takes 3.80 μs to move from X to C, calculate the speed of the ion. /1

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e) Calculate the mass of the H^+ ion using your answers from part c) and d). /2

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Total Q7 /8

Question 8

Marker use

A simple linear motor can be constructed by a placing a metal roller on top of rails 12 cm apart immersed in a magnetic field of 0.3 T. A current is then passed though the rails and roller.

Consider the Figure 10 diagram below.

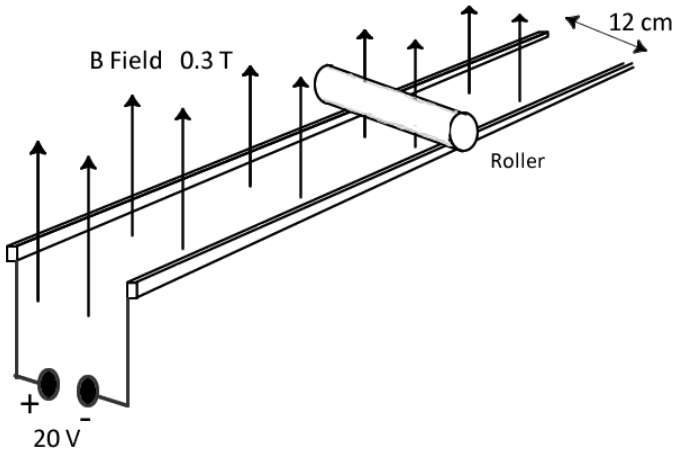

Figure 10

20 V is placed across the roller via the rails. The roller has a resistance of 0.5 Ω.

a) Calculate the initial current through the roller. /1

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b) What is the initial magnitude and direction of the force on the roller? /2

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As the roller gains speed, an induced emf is created across it which will cause opposition to its motion.

c) Ignoring mechanical friction, calculate the speed at which the roller will cease accelerating. /2

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Question 8 continues

Marker use

d) What is the current through the roller at this maximum speed? Justify your answer.

/2

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Total Q8

/7

Question 9

Marker use

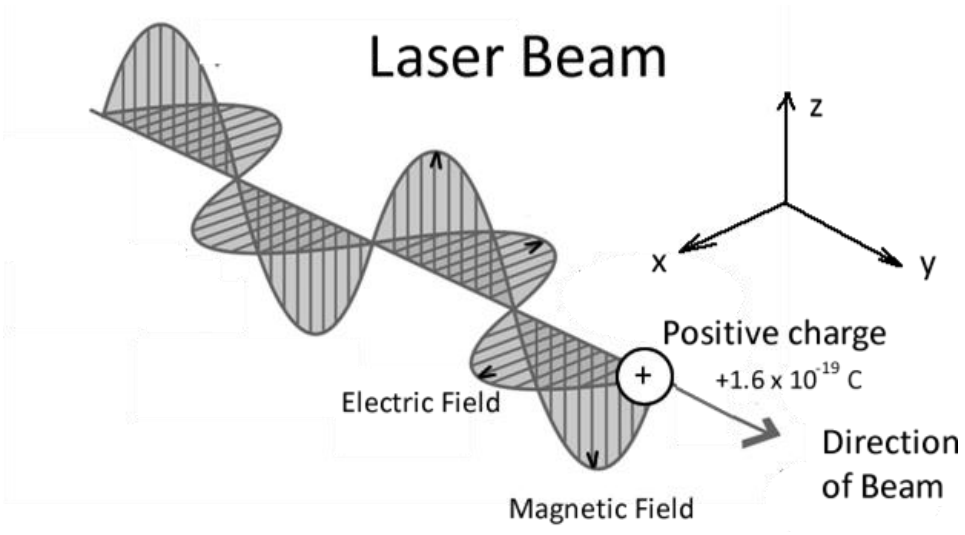

Figure 11

A laser beam of light can be considered as two rapidly changing electric and magnetic fields at right angles to each other.

Consider the beam interacting with a stationary positive charge of value $+1.6 \times 10^{-19}$ C as shown in Figure 11.

a) State the formula that can be used to determine the force on the charge:

i. Due to the electric field.

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/1

.....

ii. Due to the magnetic field.

/1

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b) As the beam strikes the charge, identify the axis (x, y or z) along which the positive charge will:

i. Accelerate due to the electric field.

/1

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Question 9 continues

Marker use

ii. Accelerate due to the magnetic field given the motion from part b) i. Justify your answer.

/2

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c) If the charge is negative instead of positive, will the direction of the acceleration due to the magnetic field be different to part b) i. and ii.? Answer **yes** or **no** and explain your reasoning.

/2

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Figure 12

Comets often have a tail of ions pointing directly away from the Sun.

/1

d) Using your answers to parts a), b) and c), explain how light can cause the ion tail to point away from the Sun.

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Total Q9

/8

Question 10

Marker use

A sheet of metal is pulled out of a magnetic field as in the Figure 13 diagram. An eddy current is formed as a result.

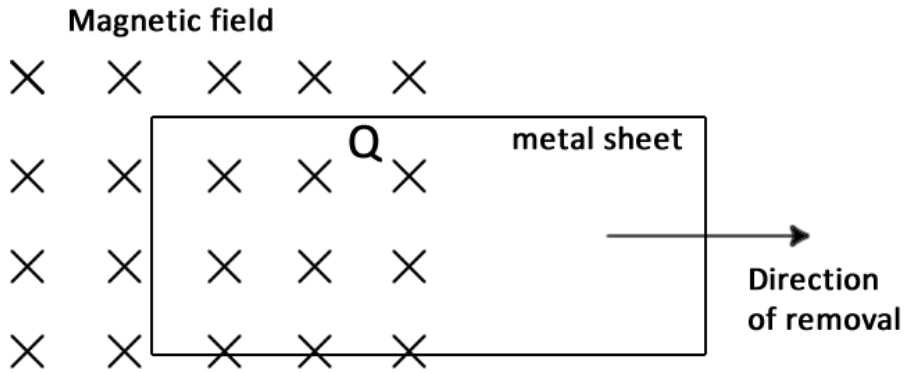

Figure 13

Spare diagram used (X) ☐

a) Will the region of Q be positive or negative? Justify your answer.

/2

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b) Sketch on the Figure 13 diagram the resulting eddy current formed in the metal.

/2

c) Identify the transfer of energy occurring while the metal is being pulled out.

/2

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Total Q10

/6

Question 11

Marker use

Two parallel wires, P and Q, are 20.0 cm apart and both carry currents **out** of the page. Wire P carries 25.0 A and Wire Q carries 5.00 A. The Figure 14 diagram below shows P and Q and the position of the point Y.

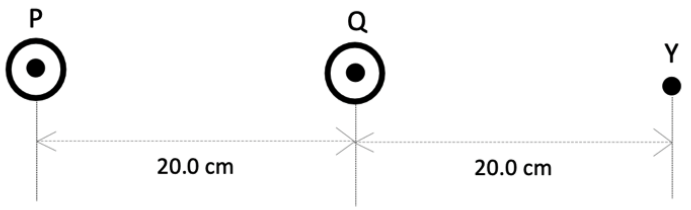

Figure 14

Spare diagram used (X) ☐

a) On the Figure 14 diagram sketch the magnetic field in the region around Wire P and Wire Q. /2

b) Calculate the force per unit length that Wire P exerts on Wire Q. /2

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c) Calculate the magnetic flux density at the point Y. /2

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Total Q11 /6

Spare Diagrams

Question 6 b)

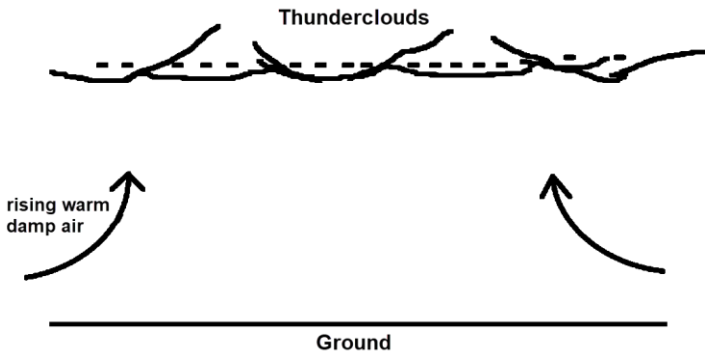

Figure 7

Question 10 b)

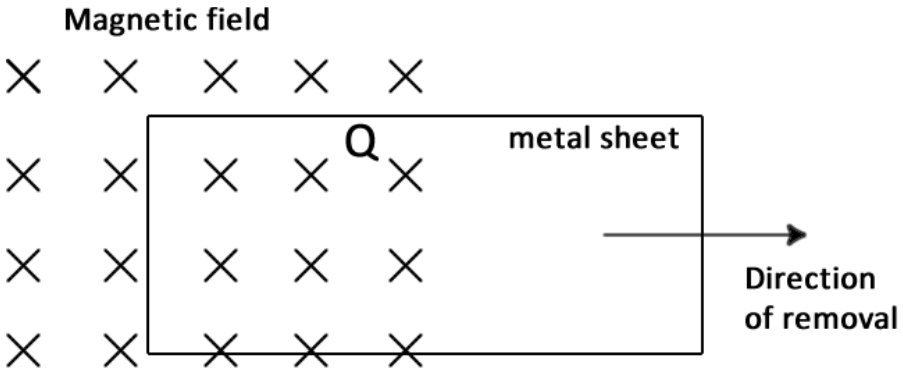

Figure 13

Question 11 a)

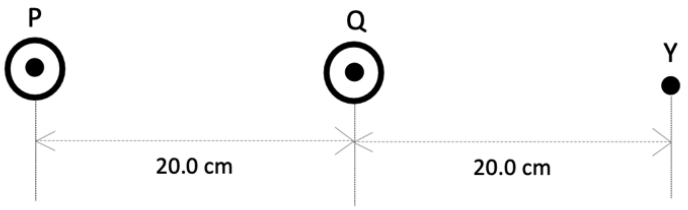

Figure 14

End of Section B

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PHYSICS

PHY415115

Section C Waves

Pages: 16
Questions: 6
Information Sheet: 1

Suggested working time: 45 minutes

Instructions:

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Marker use	
C7	/ 45

Guide to Exam Structure

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Section D	6	6	45 minutes	45 marks
Totals	**23**	**23**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 7 identify and apply general principles of wave motion.

Question 12

Marker use

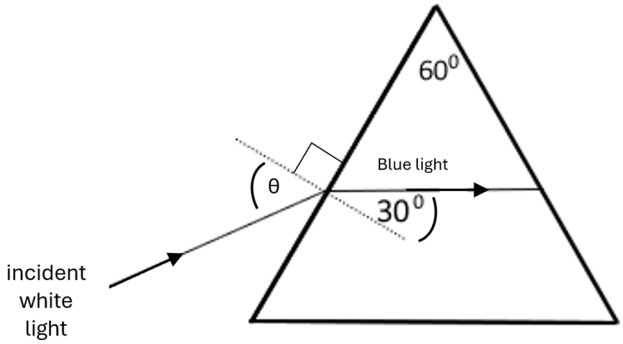

Figure 15

Spare diagram used (X) ☐

A ray of white light strikes a 60° glass prism. Blue light is refracted to an angle of 30°. The prism has a refractive index of 1.58 for blue light.

a) Calculate the angle of incidence, θ, of the white light. /2

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The refractive index for red light is 1.54.

b) Without calculation, sketch on the Figure 15: /1

i. the path of the blue light as it leaves the prism /1

ii. the path of the red light as it traverses and leaves the prism.

c) Explain the path of the red light in part b) ii. /1

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d) Calculate the critical angle of the blue light in the prism. /2

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Question 12 continues

Marker use

e) Would you expect all the refracted blue light to leave at the point in part b) i? Give reasons for your answer.

/2

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Total Q12

/9

Question 13

Marker use

A wire is stretched between two bridges on a sonometer and is tensioned by a hanging mass as shown in Figure 16. The wire has a linear density of 2.00×10^{-3} kg m^{-1}.

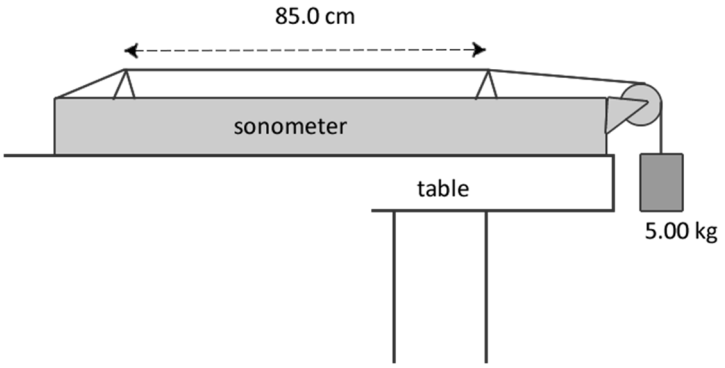

Figure 16

a) In one test, the bridges are 85.0 cm apart and tensioned with a 5.00 kg mass.

i. Show that the fundamental frequency of vibration of the wire is approximately 90 Hz. /3

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ii. Calculate the frequency of the second overtone. /1

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Question 13 continues

Question 13 continued

Marker use

A second identical wire is now also stretched 85 cm but is tensioned with a different mass. When the fundamental frequency of both are played together, the resulting tone "beats" with a frequency of 3.00 Hz.

b) What are the possible vibration frequencies of the second wire? /2

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c) Calculate the **least** mass tensioning the second wire. /3

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Total Q13 /9

Question 14

Marker use

In a Young's Double Slit experiment, two coherent colours of light are passed through slits 0.2 mm apart. One is red light, wavelength 600 nm and the other blue light of wavelength 450 nm.

The resulting fringe pattern is observed on a screen 0.5 m from the double slit.

a) What is meant by the term "coherent" when applied to light? /1

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b) Calculate the distance between each bright fringe for:

i. Red light /1

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ii. Blue light /1

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c) Show that antinodal fringes of light occur for both colours at points 4.5 mm on either side of the central bright spot. /2

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d) For the red light only, calculate how many wavelengths are in the path difference for the position in part c), 4.5 mm from the central bright spot. /1

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Total Q14 /6

Question 15

Marker use

Two buoys, A and B, are placed 60 m apart in an East – West line recording wave heights of ocean waves which are also travelling in an East – West direction as shown in Figures 17 and 18.

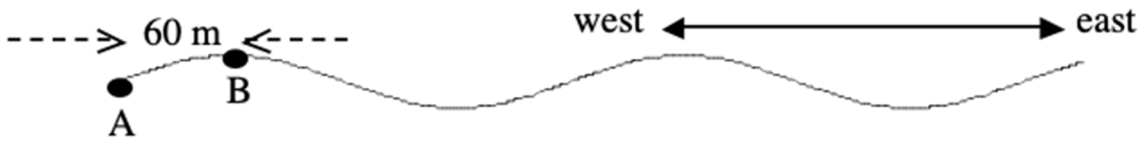

Figure 17

A plot of vertical displacement vs time for each of the two buoys is shown in Figure 18.

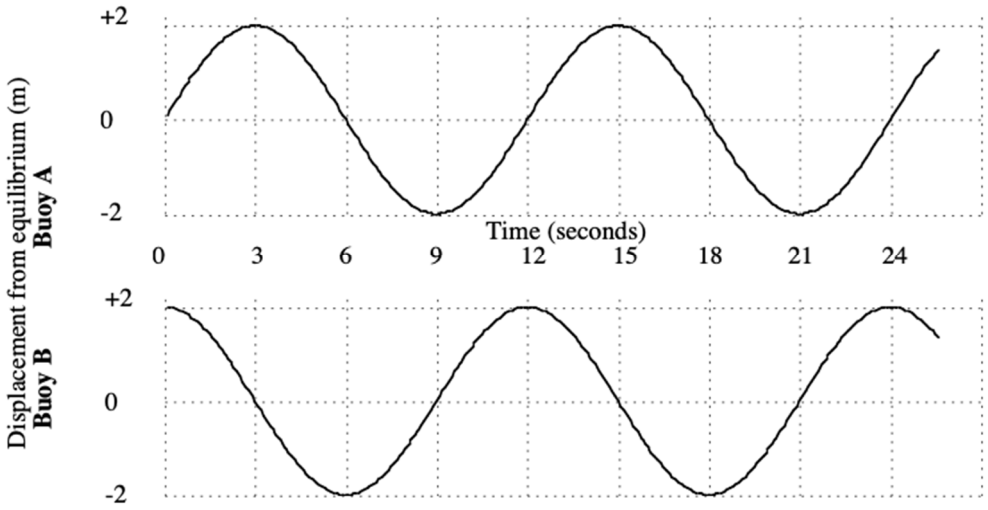

Figure 18

a) What is the amplitude of the wave?

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b) What is the period of the wave?

/1

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Question 15 continues

Marker use

c) Evaluate the wavelength of the wave. Give reasons for your answer.

/2

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d) Calculate the speed of the wave.

/1

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e) Using Figures 17 and 18, which direction is the wave travelling? Give reasons for your answer.

/2

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Total Q15

/7

Question 16

Marker use

Many sunglasses are “polarised” meaning the lenses are made from a polarising filter.

Consider unpolarised sunlight striking the surface of water as shown in Figure 19. The unpolarised light is shown in the diagram by an electric field component parallel to the surface of water by dots and the other component of equal value by arrows.

This light will be both reflected **and** refracted at the surface of the water.

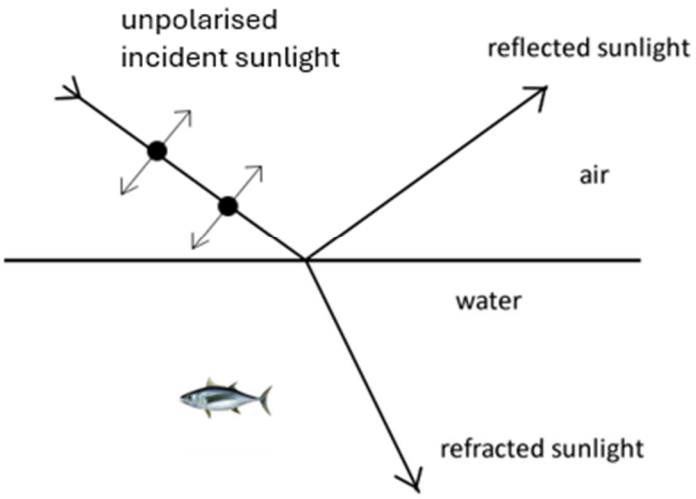

Figure 19

a) Circle **dot** or **arrow** as the main polarisation of the:

i. Reflected light **dot** **arrow** /1

ii. Transmitted light **dot** **arrow** /1

b) If the sunglasses reduce the reflected light from the water, are they good at reducing reflections from shop windows? Carefully explain your answer. /3

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Question 16 continues

Marker use

Air scatters light. Consider an observer with polarised sunglasses looking at light from the Sun scattered by 90°.

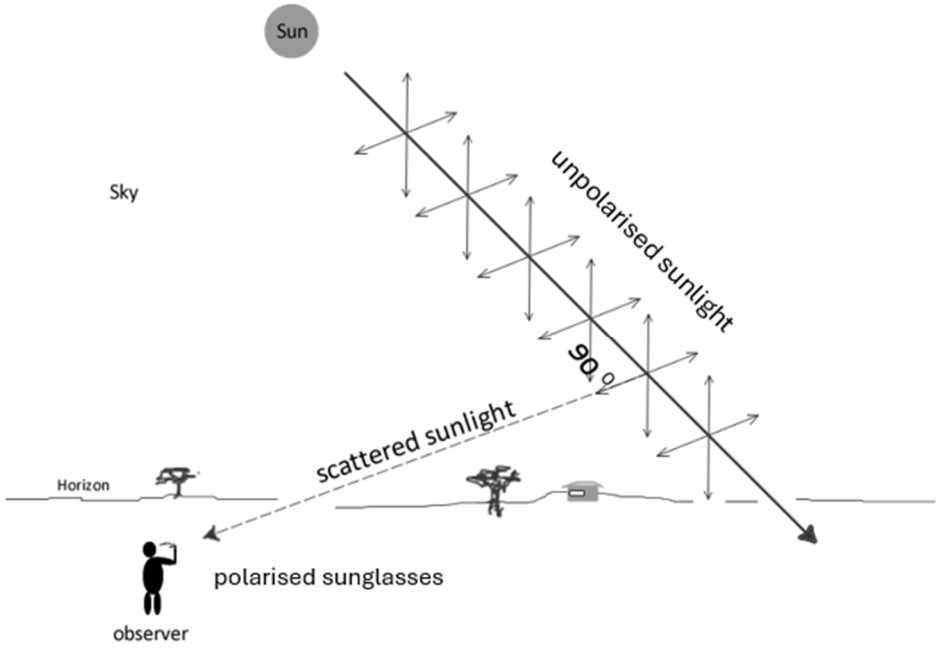

Figure 20

c) Describe what will happen if the observer looks through polarised sunglasses at light that has been scattered by 90°, and then rotates the sunglasses through 180°. Carefully explain your answer.

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Total Q16

/8

Question 17

Marker use

The human ear can be considered as a closed pipe (the ear canal to the ear drum) of approximate length 25 mm as shown in Figure 21.

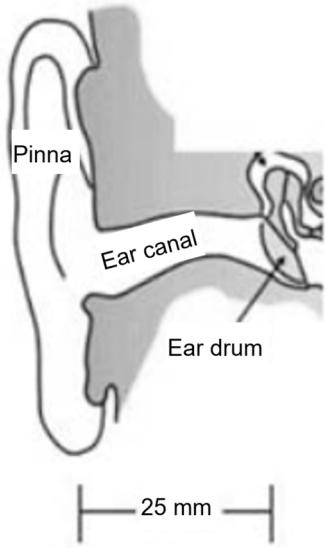

Figure 21

a) Treating the ear as a closed pipe, sketch the fundamental and first overtone wave patterns in Figure 22. /2

Fundamental standing wave pattern

First overtone standing wave pattern

Figure 22

Spare diagram used (X) ☐

b) Calculate the fundamental frequency of a closed pipe of this length. /2

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Question 17 continues

Marker use

/2

Adult human ears are most sensitive to frequencies between 2 kHz and 5 kHz and also 9 kHz to 12 kHz.

Small children, however, are most senstive to frequencies above 8 kHz.

c) Using parts a) and b), discuss this.

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Total Q17

/6

Spare Diagrams

Question 12 b)

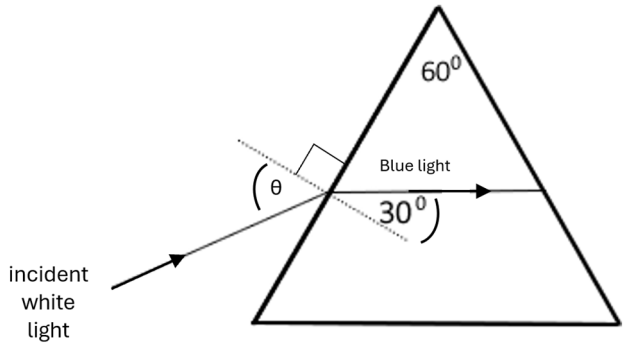

Figure 15

Question 17 a)

Fundamental standing wave pattern

First overtone standing wave pattern

Figure 22

End of Section C

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PHYSICS

PHY415115

Section D Twentieth Century

Pages: 12
Questions: 6
Information Sheet: 1

Suggested working time: 45 minutes

Instructions:

- Answer **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
- A spare diagram has been provided at the end of this section. Indicate in the box provided if you have used the spare diagram.
- TASC-approved scientific calculators can be used throughout the exam.
- The Physics Information Sheet can be used throughout this exam.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 45 minutes**.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C8	/ 45

Guide to Exam Structure

	Questions available	Questions to answer	Suggested working time	Marks available
Section A	5	5	45 minutes	45 marks
Section B	6	6	45 minutes	45 marks
Section C	6	6	45 minutes	45 marks
Section D	6	6	45 minutes	45 marks
Totals	**23**	**23**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 8 identify and apply principles of the wave-particle nature of light, atomic and nuclear physics and models of the nucleus and nuclear processes.

Question 18

Marker use

Handheld remote thermometers measure the microwave emission peak emitted by warm bodies. They are sensitive to the range of 7.5 – 14 μm wavelengths.

Figure 23

a) Calculate the range of temperatures for which the thermometers are most likely to be accurate.

/3

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b) Would these sensors be likely to provide accurate readings of the temperature of the Sun's surface – approximately 5 800°C? Justify your answer.

/2

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Total Q18

/5

Question 19

Marker use

In 1917, Rutherford observed that α particles from a source striking nitrogen produced a long-range radiation subsequently recognised as the proton. The reaction is as follows:

$$^{4}_{2}He + {}^{14}_{7}N \rightarrow {}^{17}_{8}O + {}^{1}_{1}p.$$

The masses of the particles are:

$^{1}_{1}p$ = 1.007276 u

$^{17}_{8}O$ = 16.999131 u

$^{14}_{7}N$ = 14.003074 u

$^{4}_{2}He$ = 4.001506 u.

a) Calculate the mass difference in the reaction.

/2

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b)

i. Is energy released or absorbed in this reaction?

/1

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ii. Calculate the value of this energy in MeV.

/1

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Question 19 continues

Question 19 continued

Marker use

The size of a nitrogen nucleus is about 3×10^{-15} m (3 fm).

c) Calculate the force of repulsion between a nitrogen nucleus and the α particle at a separation of 4 fm and use this to argue for the existence of a nuclear force.

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Total Q19

/7

Question 20

Marker use

A photon with a wavelength of 2.484×10^{-11} m strikes an electron and is scattered at an angle of 180° from its original direction. After scattering, its wavelength is 2.967×10^{-11} m.

a) Calculate the momentum of:

i. The incident photon.

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/1

ii. The reflected photon.

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/1

b) Show that the speed of the electron after the collision is 5.4×10^{7} m s^{-1} (0.18c).

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/4

c) Show that energy appears not to be conserved in this collision.

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/4

d) Suggest the effect that has not been taken into account in the energy calculation.

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/1

Total Q20

/11

Question 21

Marker use

In nuclear medicine, $^{224}_{88}Ra$ has been used for treating a condition called ankylosing spondylitis, a type of arthritis. It has a half-life of 3.823 days and is an α particle emitter.

Typically a sample of activity of 6.0 MBq is injected into the patient.

a) Write the decay equation in terms of the decay product, X.

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/1

b) Calculate the number of atoms injected into the patient.

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/2

c) After 10.0 days, what is the activity of the remaining sample of radium $^{224}_{88}Ra$?

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/2

Total Q21

/5

Question 22

Marker use

Sodium atoms are bombarded with electrons in a vacuum tube. Some of the energy levels of atomic sodium are shown in Figure 24.

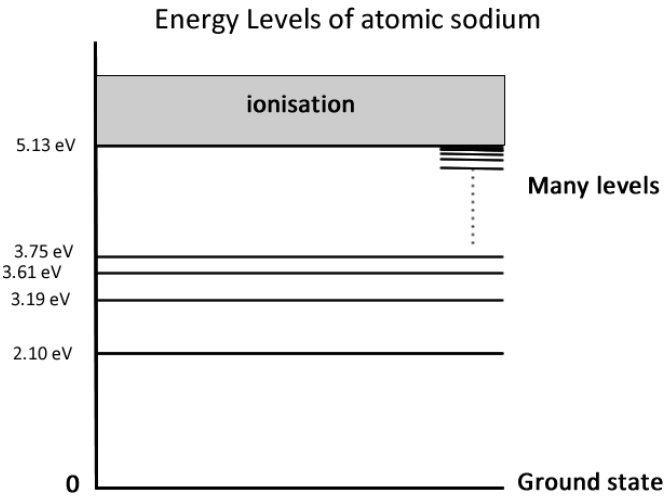

Figure 24

Spare diagram used (X) ☐

a) Calculate the minimum energy to excite an electron from a ground state atom in joules. /1

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The atoms in ground state are bombarded with electrons at 3.30 eV.

b) Show on Figure 24, possible transitions as the atom reverts to ground state. /2

c) Calculate the possible photon energy or energies in joules associated with these transitions. /2

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Question 22 continues

Marker use

d) Calculate the possible energies (in eV) of the scattered electrons.

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e) If sodium atoms are bombarded with 10 eV electrons, calculate the frequency of the highest energy photon that sodium will emit.

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Sodium emits photons of yellow-orange light very strongly at a wavelength of 589 nm.

f) Which two energy levels in Figure 24 are responsible for this wavelength?

/2

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Total Q22

/10

Question 23

Marker use

Light of wavelength 200 nm falls on a clean aluminium surface in a photoelectric tube.

a) In what region of the electromagnetic spectrum is this light?

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/1

The work function of aluminium is 4.2 eV.

b) Calculate the maximum kinetic energy of any emitted photoelectrons in eV.

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/2

The range of energies of photoelectrons varies from 0 eV up to the maximum value.

c) Explain why this range of kinetic energies exists. Use a diagram if necessary.

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/2

d) Calculate the minimum photon frequency required to eject photoelectrons from aluminium.

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/2

Total Q23

/7

Spare Diagrams

Question 22 b)

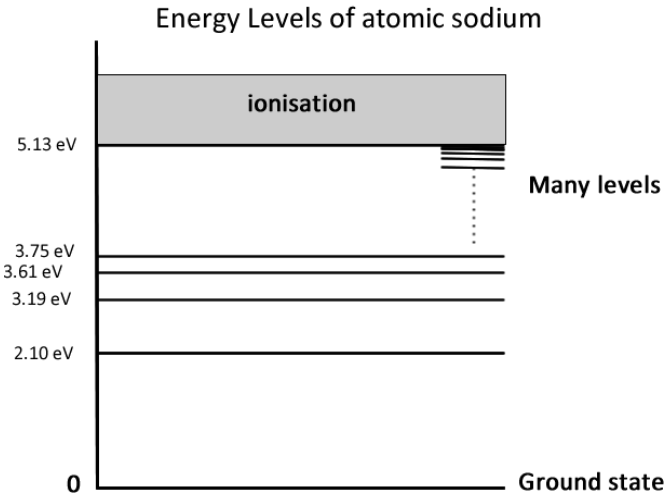

Figure 24

End of Exam

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