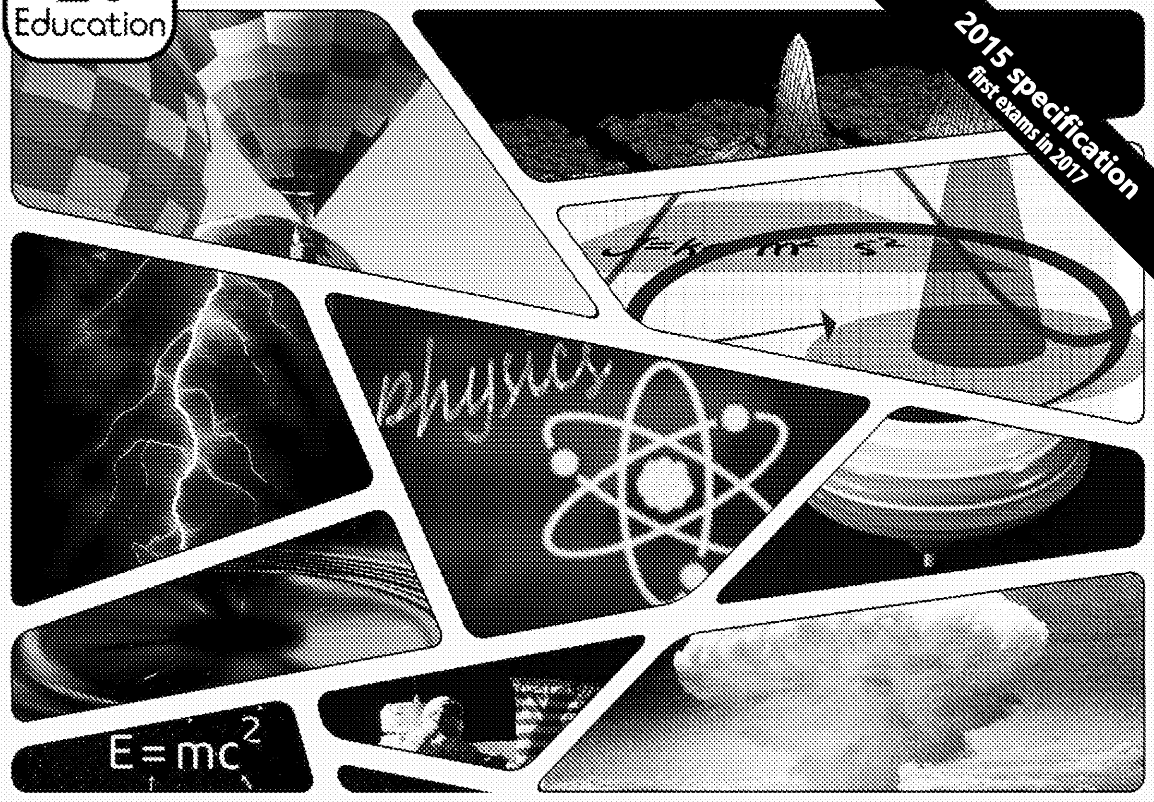
Physics A Level | OCR | 7408



2015 specification
first exams in 2017

Topic Tests

for A Level OCR Physics A Modules 5 and 6

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Contents

Teacher's Introduction

These topic tests have been designed to help you and your students assess knowledge of a topic after you have taught each section of **A Level OCR A Physics Module 5: Newtonian World and Astrophysics** and **Module 6: Particles and Medical Physics** (for first teaching in September 2015).

Each topic test closely follows the content of the specification and includes:

- **Factual questions**: Some simpler factual questions are included to ensure that all the content and basics are covered, and to allow weaker learners access to some marks.
- **Short-answer questions**: These are not in exam style, and the purpose of these is to test different elements, knowledge and skills from the specification in a variety of styles.
- **Exam-style questions**: Where appropriate, topics may contain one or more exam-style questions, to prepare students for what they might meet in the exam, and to test exam skills.

Mathematical and practical skills are also covered in these Topic Tests.

Tests have been designed to take approximately 25–60 minutes and most contain on average between 25 and 40 marks, though please note that marks fall outside this range where some topics require more detailed knowledge and assessment. Please note that some tests have been combined or split, as shown in the table:

Module 5: Newtonian World and Astrophysics

Topic Number	Number of Marks
5.1.1/5.1.2/5.1.3	40
5.1.4	35
5.2	40
5.3.1/5.3.2	45
5.3.3	24
5.4.1/5.4.2	32
5.4.3	42
5.5.1	40
5.5.2	26
5.5.3	43

Module 6: Particles and Medical Physics

Topic Number	Number of Marks
6.1	38
6.2.1 + 6.2.2 + 6.2.3	7 + 14 + 14 = 35
6.2.4	16
6.3.1 + 6.3.2	14 + 20 = 34
6.3.3	36
6.4.1 + 6.4.2	17 + 34 = 51
6.4.3	30
6.4.4	37
6.5.1 + 6.5.2 + 6.5.3	17 + 13 + 18 = 48

The topic tests are suitable for a classroom assessment, revision aid or homework task and are, therefore, suitable for use immediately after a topic is completed in class or at the end of teaching the course.

Students are able to see the number of marks awarded for each question, allowing them to gauge the level of detail they will require for the answers, as in exam conditions. Full answers with marks are included at the end of the resource. Additionally, it makes the resource a suitable tool for students to use independently.

It is recommended that students have access to a calculator and a data sheet to complete the questions.

I hope you find these tests useful during your teaching.

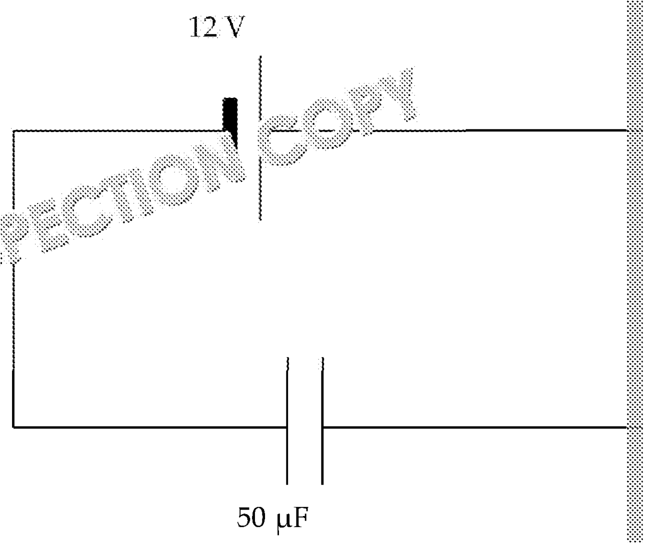
Remember!

Always check the exam board website for new information, including changes to the specification and sample assessment material.

6.1.1 Capacitors

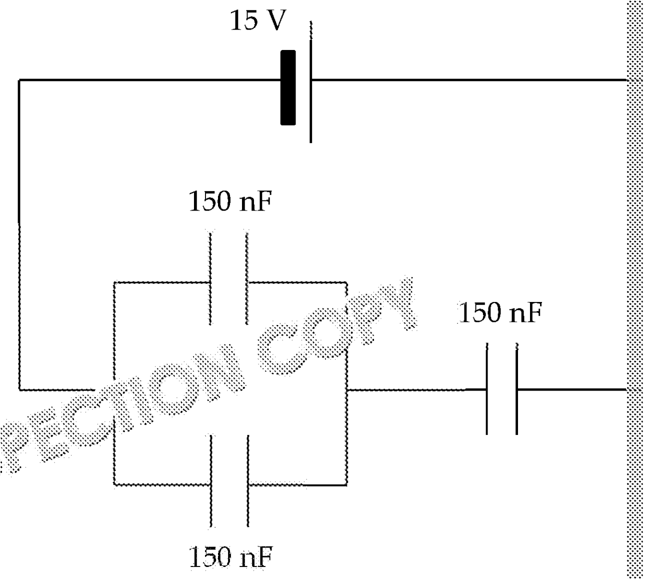
1. Explain what the term 'capacitance' means.

2. A simple circuit is set up as below:



   a) Explain how the charge builds up across the capacitor plates.
   b) Calculate the charge stored on the charged capacitor plates.
   c) Calculate the number of electrons stored on the plates.

3. A group of Year 12 physicists set up the following circuit to analyse h in series and parallel circuits.

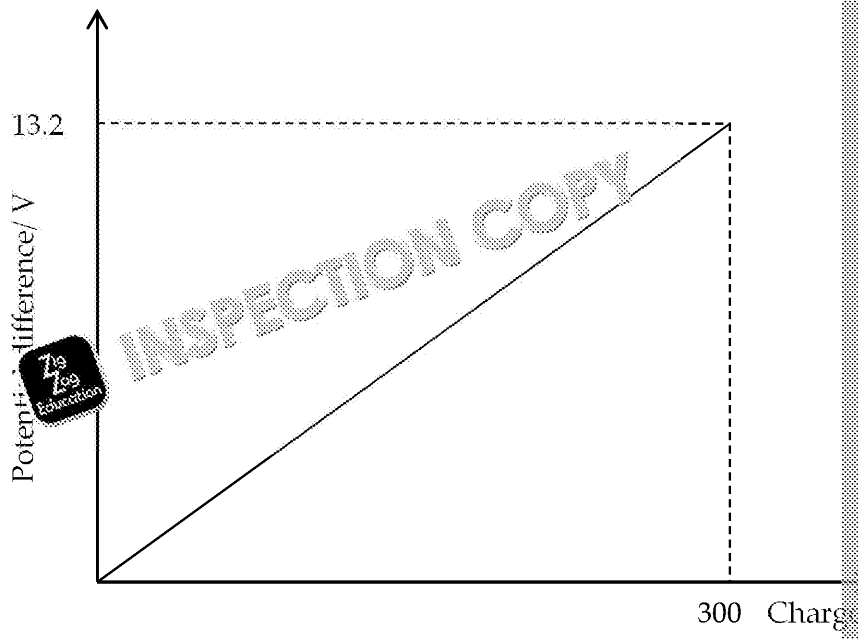


   a) Explain how the group could connect a voltmeter and ammeter i determine how to calculate the total capacitance when capacitors
   b) Calculate the total capacitance present in the circuit.

6.1.2 Energy

4. The group reassemble the circuit so that it just includes one of the cap investigate the energy stored on the capacitor plates.

   They plot their results to obtain the following:

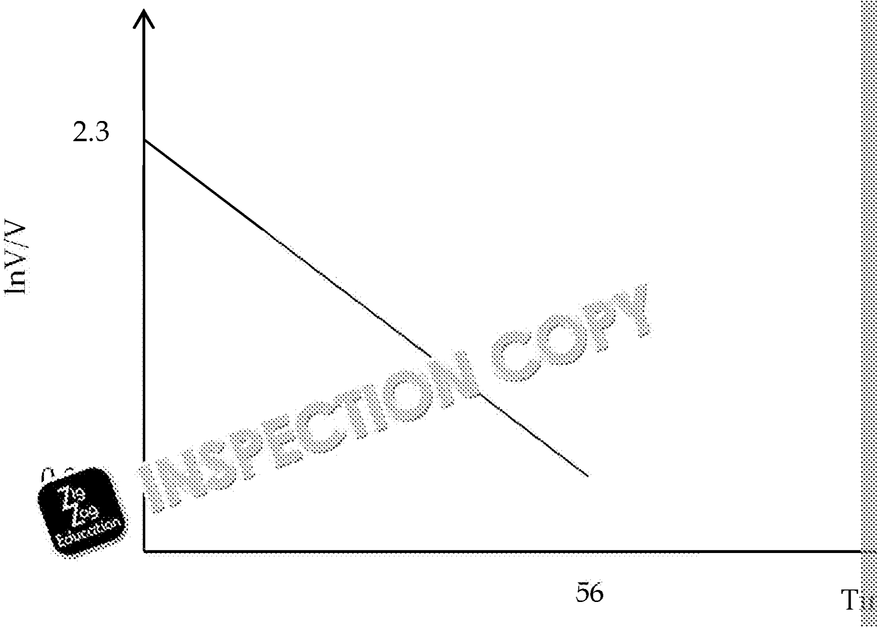


   a) Explain where the energy stored on the capacitor plates comes fr
   b) Calculate the energy stored on the capacitor.
   c) Calculate the capacitance of the plates.
   d) Suggest two potential uses of capacitor plates.

6.1.3 Charging and discharging cap

5. a) i) Sketch a circuit set-up that could be used to charge and disch through a resistor.
      ii) Explain how the current, charge and voltage across the capaci circuit.
   b) Sketch the graphs of the relationship of V, I across the resistor an capacitor against t as the capacitor discharges.
   c) State the decay constant for each graph.
   d) Calculate the charge present on the plates of a 550 μF capacitor af discharging through a 70 kΩ resistor if the initial charge present w
   e) Using the constant ratio property of the graph, calculate the charg capacitor after another 40 seconds of discharging through the res

6. A graph is used to plot the data obtained for pd voltage and time dur
capacitor:



a) Determine the maximum voltage across the capacitor plates.
b) When t=τ, estimate the potential difference across the plates.
c) From the graph, calculate resistance of the resistor through which
discharged.

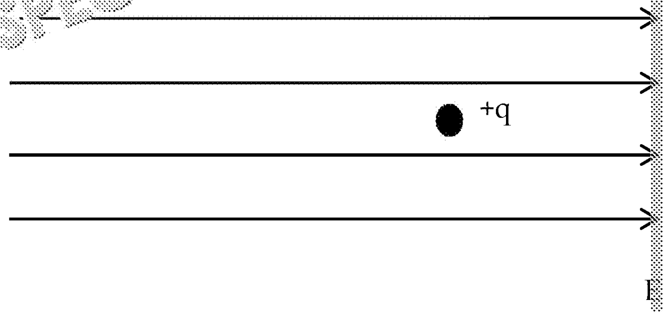
6.2.1 Point and spherical charg

1. State the property that forms an electric field.

2. Sketch the field lines:
   - of a negative point charge.
   - of a uniformly charged sphere
   - between a positive and negative point charge

3. Explain what electric field lines represent.

4. A proton of charge 1.6×10^{-19} C is moving left to right in an electric field
10^3 NC^{-1}.



Calculate the constant force that the proton experiences as it travels withi

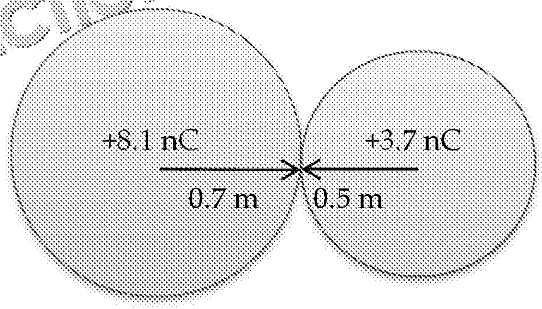
6.2.2 Coulomb's law

1. State another type of field that also gives rise to a non-contact force.

2. All the particles that make up atoms and the matter around us produ
between them. This creates an attraction between particles.

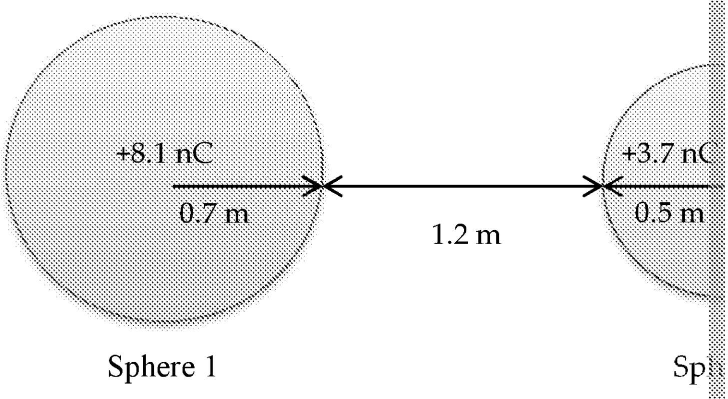
Calculate the electrostatic force between two protons in the nucleus o
($e = 1.60 \times 10^{-19}$ C, $\varepsilon_0 = 8.85 \times 10^{-12}$ Fm^{-1} $m_p = 1.67 \times 10^{-27}$ kg) that sit 1

3. Two uniformly charged spheres are placed in contact with each other



a) Calculate the electrostatic force between them.

The distance between the centre of the spheres is then doubled.



b) By calculation, indicate the effect on the electrostatic force betwee
separation is doubled.

c) Calculate the electric field strength of Sphere 1 felt at Sphere 2's s

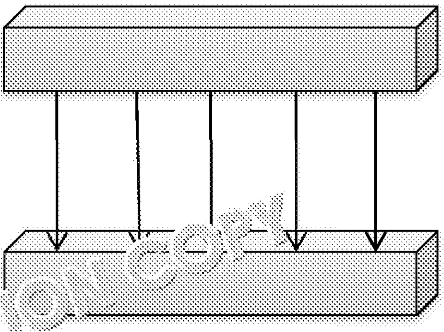
The electric field of the sphere can be used as model comparison to t
gravitational fields created by planets.

d) Explain the similarities between electric fields and gravitational f
spheres can act as good models of planets.

e) Explain situations where electric fields differ and an accurate com

6.2.3 Uniform electric fields

1. The plates have a potential difference of 10 V and a cross-sectional are
The electric field strength between the plates is 5.2×10^5 Vm^{-1}.



a) St[illegible]hi[illegible]e is positive.
b) C[illegible]e the distance between the plates.
c) Calculate the capacitance between the plates.

A sheet of glass is placed in-between the two capacitor plates. The gla
dimensions as the space between the plates.

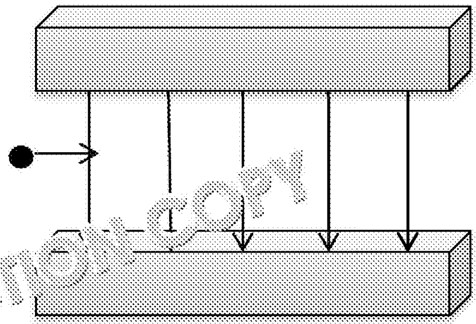
d) Explain the effect this will have on the capacitance of the capacitor co

A proton ($m_p = 1.67 \times 10^{-27}$ kg) is released from rest from the top pl
towards the bottom plate.

Assume that the force due to gravity is negligible compared to the for
due to the electric field.

e) Calculate the final speed of the proton as it reaches the bottom pl

A proton enters the plates from the left at rest and is accelerated as it p
The lengths of the plates are 0.07 m and it takes the proton 1.2×10^{-7} s



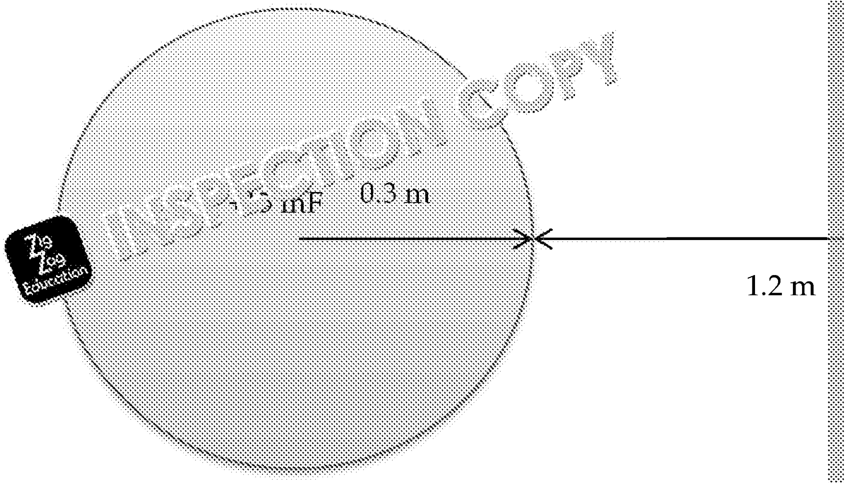
f) S[illegible]he path the proton will take as it travels between the plat
g) Calculate the horizontal component of the proton's velocity.
h) Compare the proton's final vertical component of velocity with y

6.2.4 Electric potential and ener

1. Explain what is meant by the term 'electric potential'.

2. Explain what happens when two opposing charges are separated or w charges are brought together.

3. An isolated charged sphere of +15 mF sits 1.2 m from a small point ch



   a) Calculate the electric potential felt by the small point charge at 1.2
   b) Explain what would happen to the electric potential felt if the sep the sphere and the point charge doubled.
   c) Derive the equation for the capacitance of the isolated sphere.
   d) Calculate the capacitance of the sphere.

4. Electrons inside an atom will exert an electrostatic force on all the oth make up an atom and on all the atoms that make up the molecule (an

   a) Sketch a force–distance graph for an electron.
   b) Explain how this graph would differ for a negatively charged sph
   c) Explain how you could determine the total work done to move a infinity to separation r (radius of the electron).

   The work done in moving a proton in an electron's electric field is 2.3

   d) Calculate the distance the proton has moved in the field.
   e) Explain what the work done would be if the proton was moved i

6.3.1 Magnetic fields

1. State two situations that give rise to a magnetic field.

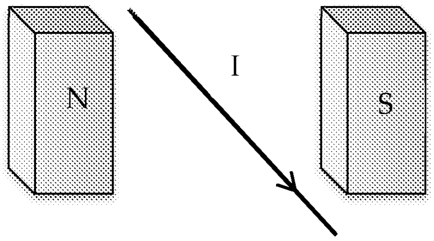
2. Sketch the magnetic field lines of the following:
   - magnet
   - long solenoid

3. Any current carrying wire produces a magnetic field. The wires used
around your house carry a current and, therefore, produce their own

   a) Sketch the magnetic field lines of the wire when the current is flowing

   b) Explain whether the field lines would differ if the current was flow

   The example wire of length 0.02 m carries a current of 1.3 A. The exan
in-between two poles with magnetic flux density is 0.23 T.



   c) Use Fleming's left-hand rule to explain the motion of the wire wh
magnetic field.

   d) Calculate the force exerted on the wire in the magnetic field.

   The wire is now twisted round in the magnetic field and no longer sit
direction of the field.

   The wire now sits at an angle of 32°.

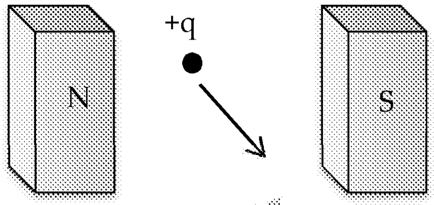
   e) Explain whether the force exerted on the wire alters.

   f) Describe an experiment to prove your answer to (e).

   g) How would the force alter if the experiment was carried out on a

6.3.2 Motion of charged particl

1. A proton is travelling perpendicular to the field at a speed of 4.4×10^4
0.12 T.

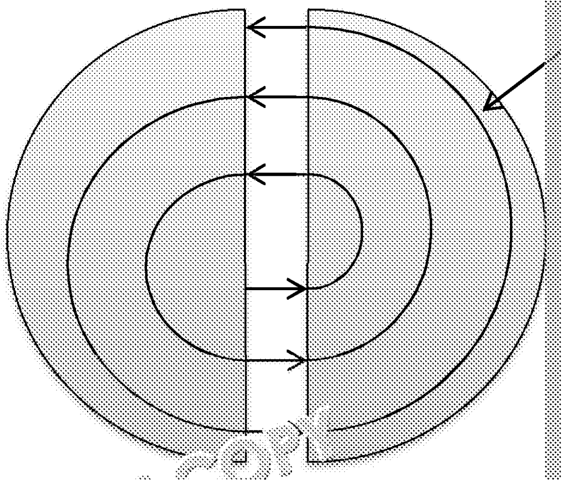


   a) Calculate the force on the moving proton.
   b) State the direction of the force exerted on the proton.
   c) Calculate the acceleration of the proton as it moves in-between th

2. Radiotherapy is a treatment used to eradicate cancer from the body. I
beams of radiation onto an affected area of the body to destroy the ca

   Radiation, despite being useful for destroying cancer cells, can also de
   To reduce the amount of healthy tissue exposed to the radiation the b
   in one direction.

   A cyclotron, a particle accelerator, is made up of two D-magnetics to l
   accelerate the particles and direct them in one direction:



   a) Explain how the magnetic field causes the beam to follow its circu

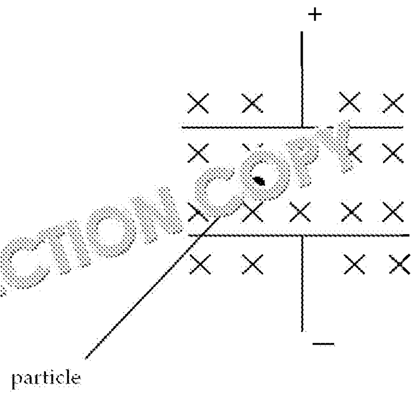
   An electron leaves the cyclotron with a kinetic energy of 4.65×10^{-18}
   magnetic flux density of 0.7 T.

   b) Calculate the maximum radius the electrons will obtain.
   c) Calculate the time it will take for an electron to complete the last

3. Velocity selectors use both magnetic and electric fields in their set up. the fields can be used to choose a charged particle's velocity as it trav

   The selector is comprised of two horizontal charged plates to create a magnetic field set up perpendicular to the electric field.

   The magnetic flux density is 0.33 T and the electric field strength is 3.



   a) Draw the force diagram of the forces acting on a charged particle deflected.
   b) Calculate the speed of the charged particle when the beam is not

   Mass spectrometers use velocity selectors to determine the mass conc

   c) Explain why it is important to have the option of choosing the ve particles in a mass spectrometer.

   A singly ionised ion travels with a speed of $2.8\times10^{5}\ ms^{-1}$ in a magnet density 0.5 T. The radius of curvature is 1.31×10^{-2} m.

   d) Calculate the mass of the ion.

   A larger singly ionised atom is used in the mass spectrometer.

   e) Suggest what you could deduce about the ion's radius of curvatu the ion discussed in (d).

6.3.3 Electromagnetism

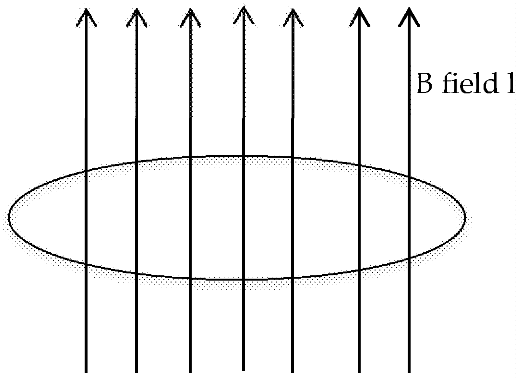
1. Explain what is meant by the term 'electromagnetism'.

2. An electromotive force (emf) is induced across a coil when a magnet i
   away from a metal coil.

   Explain what type of current will be present in the coil.

3. Define the term 'magnetic flux'.

4. A current-carrying wire is bent round into a circular loop. The wire ha
   The field line present has a flux density of 0.2 T.



   a) Calculate the magnetic flux through the current-carrying loop.
   b) Explain how the flux would differ if the coil was rotated to sit at a
   from the magnetic field.

   A similar set-up is used for a solenoid. It is constructed from a long cu
   that wrapped upon itself to create 30 turns in the circular loop.

   c) Calculate the magnetic flux linkage.

5. A search coil, consisting of 1,450 turns and a cross-sectional area of 0.
   an experiment to measure fluctuations in magnetic flux.

   The coil is initially placed perpendicular to the field of a magnet with
   and is rotated in the field over five seconds to an angle of 47 °.

   a) Explain Faraday's law of induction.
   b) Explain how [illegible] the understanding of induction develope
   constant of proportionality to be –1.
   c) Calculate the change in flux linkage over this time.
   d) Calculate the induced emf in the coil.
   e) Explain how the induced emf would change if the number of coils i
   was increased.

6. Describe an experiment using a search coil that could investigate mag

7. AC generators are useful devices for supplying power to machines su

   a) Explain how an AC generator works.
   b) Sketch the graph of how flux linkage varies with time.
   c) Explain how you could determine the induced emf from the grap
   d) Explain what you can deduce about the value of induced emf wh

8. A transformer is set up with an input of 11 V connected to its primary

   a) Calculate the voltage in the secondary coil that has 2,000 turns.
   b) Determine the ratio of current between the two coils.
   c) Explain how the relationship between V_s and V_p would alter if th
      been a step-down transformer.

9. The national grid uses transformers to supply power to homes all acr

   a) Explain how transformers are used in the process of getting elect

   A relatively small power station will supply 1 MW of power and 230

   b) Calculate the power lost when the cables used have a resistance o
   c) Explain why power is lost in the cables.
   d) Suggest how the station could reduce the amount of power lost i

6.4.1 The nuclear atom

1. Explain how Rutherford's scattering experiment provided evidence th smaller particles that formed a charged nucleus.

2. The idea of an atom being comprised of constituent parts is a very old ancient cultures. Our knowledge of the atom has developed significa
   a) State the properties of the simple nuclear model of an atom.

   Given that nucleus of a hydrogen-3 atom can be written in the form $^3_1$
   b) state the proton number and the nucleon number
   c) determine the number of neutrons in the nucleus of a hydrogen-3
   d) calculate the volume of the nucleus
   e) calculate the approximate density of the nucleus
   f) calculate the approximate density of a hydrogen-1 atom ($R_H \approx \times 1$ that the mass of the electron is negligible.

3. Two charged particles of the same charge will exert repulsive forces o in the nucleus of any atom. The protons that make up the nucleus of a other due to having the same charge.
   a) Explain why protons in the nucleus remain in close proximity to e remains bound together when there are repulsive forces present.
   b) Sketch the graph of nuclear force against the separation of two nu range properties.

6.4.2 Fundamental particles

1. State the anti-particles of the following particles:
   - Proton
   - Neutron
   - Electron
   - Neutrino

2. Comment on the mass and charge of anti-particles.

3. Despite the idea of the atom being comprised of smaller parts being a an understanding that these parts were comprised of smaller parts fu development.

   The term 'subatomic particle' only started to be discussed in the 1960s
   a) State the two classification groups of subatomic particles.
   b) State two examples of each.
   c) Comment on the properties of each group of subatomic particles.

4. a) Explain what is meant by a fundamental particle.
   b) State the different flavours of quarks and their respective anti-qu
   c) i) State the quark model for a proton and neutron.
      ii) Use the quark model to confirm that charge of a proton is $+e$ a neutron is 0.
      iii) Hence determine the charge of their anti-particles.
   d) Using its quark model, explain whether a proton is a baryon or a

5. Radioactive decay is a useful process that can produce huge amounts harnessed for various uses.
   a) Explain why a nucleus would emit radiation.
   b) State what particles are emitted during each beta decay.
   c)
      - State the particle transformation during each beta decay.
      - State the quark transformation during each beta decay.
   d) Complete the following decays:

$$c \rightarrow s + {}^{0}_{+1}e + ?$$

$$c \rightarrow s + u + ?$$

   e) Comment whether the following decay is valid:

$$s \rightarrow u + d + u$$

6.4.3 Radioactivity

1. Explain the two terms used to describe the behaviour of radioactive d

2. a) State the three main types of radiation.
   b) Comment on the nature, penetration and range of each.

3. a) Describe an experimental method, involving a GM tube, that cou half-life of protactinium-234.
   b) Suggest a consideration that would need to be taken during this e accurate results.
   c) State the dangers associated with working with radioactive subst which to reduce them.

4. a) State the properties conserved during radioactive decay.
   b) Complete the following general radioactive decay equations and represented in each:

$$^{A}_{Z}X \rightarrow {}^{A-4}_{Z-?}Y + {}^{4}_{2}He$$

$$^{A}_{Z}X \rightarrow {}^{A}_{z+?}Y + {}^{0}_{-1}e + ?$$

$$^{A}_{Z}X \rightarrow {}^{A}_{Z}X + ?$$

   c) i. Predict the isotope in the following decay:

$$^{219}_{86}Rn \rightarrow {}^{?}_{?}Po + {}^{4}_{2}He$$

   ii. Indicate what type of radiation will be emitted in the followi

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + ?$$

5. Radioactive substances are used in brachytherapy, which is a treatme involves placing the radioactive source directly inside the patient nea the cells directly.

   a) Explain what is meant by the activity of a source.

   Strontium-89 is a radioactive substance used in treatments involving life of the isotope is 50.53 days.

   b) Calculate the decay constant of strontium-89.

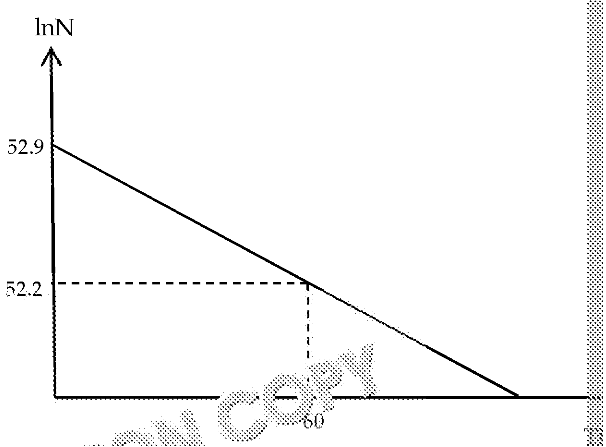
   Depending on the isotope used it may be necessary to keep the patien time due to the radioactivity emitted. It is considered safe once the ac reduced by 8% of its original value.

   c) Calculate how long a patient would have to be in isolation for.
   d) If the general decay equation for strontium-89 is:

$$^{89}_{38}Sr \rightarrow {}^{89}_{39}Y \rightarrow ? + \bar{v}_e$$

   State which radiation is emitted to destroy the cancer cells' struct

6. Medical physicists plot the graph of another radioactive isotope, iodine-1



a) Calculate the decay constant for iodine-125.

Iodine-125 and strontium-89 both have relatively short half-lives.

b) Suggest a reason why these particular isotopes were chosen for u
treatments.

Radioactive decay processes can also aid scientists in dating all things
They allow scientists to date materials spanning the last 50,000 years a
length.

c) Explain how carbon dating can be used to determine the time sinc

6.4.4 Nuclear fission and fusio

1. State the two conclusions that can be drawn from Einstein's mass–ene

2. Einstein's mass–energy equation can be applied to any moving mass. everyday lives but usually the change in mass is negligible and its eff

   At rest a cyclist weighs 65 kg. Once she begins cycling she travels at a Calculate her change in mass as she begins to cycle.

3. Explain the conservation of mass-energy that occurs during radioacti

4. Calculate the kinetic energy released during the following reaction:

$$^{232}_{90}Th \rightarrow {}^{228}_{88}Ra + {}^{4}_{2}He$$

   (m_{Th} [illegible] u; $m_{Ra} = 228.031064\ u$; $m_{He} = 4.002602\ u$; $1u \approx 1$

5. a) Indicate the decay process of induced fission.
   b) Explain what would happen if the fast-moving neutrons released harnessed and slowed down.
   c) How has society utilised the consequence of (b)?

6. A new nuclear power station has been commissioned and scientists ar together to create a safe design.

   a) Explain the basic structure of a nuclear reactor.
   b) Suggest the considerations the scientists and architects will need about the environmental impact of the waste produced by the sta

7. a) What type of reaction is illustrated in the following process (give

$$^{1}_{1}p + {}^{1}_{1}p \rightarrow {}^{2}_{1}H + {}^{0}_{+1}e + v$$

   b) Complete the following process for the same reaction:

$$^{2}_{1}H + {}^{1}_{1}p \rightarrow {}^{?}_{?}He$$

   c) Explain why there are no power stations utilising this type of rea

8. a) Explain the conversation of mass-energy that occurs during annil

   An A Level student is investigating the energy released during annih

   The student is focusing on electron-positron annihilation and predicts gamma rays formed from the annihilation must have energy of 6.8 ×

   b) Comment whether the student's prediction is correct or incorrect

   The student also predicts that if the electron and positron had been m the energy of the gamma ray would be increased.

   c) Is the student correct in their prediction? Give a reason for your a

9. The binding energy refers to the amount of energy required to separa constituent parts.

   a) Explain why the sum of masses of the constituent parts of a nucle the mass of the atom.
   b) Calculate the binding energy of a helium-4 nucleus (${}^{4}_{2}He$) with a ($m_p = 1.007276$ u; $m_n = 1.008664$ u; 1u $\approx 1.66 \times 10^{-27}\ kg$)
   c) Calculate the binding energy per nucleon of a hydrogen-3 nucleu atomic mass 3.0160492 u.
   d) Explain which nucleus would be harder to break apart.
   e) Sketch general graph of binding energy per nucleon against the n
   f) Identify which sections of the graph relate to different radioactiv

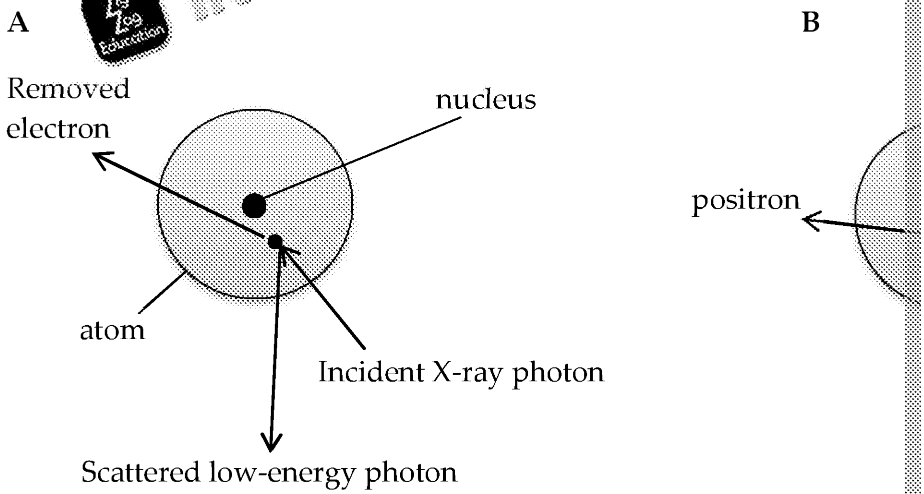
6.5.1 Using X–rays

1. a) Sketch a diagram of an X–ray tube that includes labels of its key c
   b) Explain how the equipment drawn in your diagram produces X–

2. A patient with a broken wrist is getting an X-ray taken in hospital.

   The X-ray beam is directed towards the wrist and achieves a transmit 11.7 W when it passes through the soft tissue in the patient's hand. Th coefficient of soft tissue is 0.54.

   a) Explain how simple scatter and the photoelectric effect would ca the X–ray beam transmitted to the patient to decrease from its ori
   b) Identify the two attenuation mechanisms represented in the follo explain how these mechanisms cause attenuation of the rays.



   c) Calculate the initial intensity of the X–ray beam that has travelled it has passed through the patient.

   Soft tissue has a very low absorption coefficient compared to bone or

   d) Explain what effect this would have on the visibility of structures on the X-ray images.
   e) Explain how you could counteract the effect of low absorption.

3. When patients have a medical condition, such as cancer where tumou scans are used more often than X-ray scans.

   a) Sketch a diagram of how CAT scans can be used for this type of i labelling each key feature.
   b) Explain why CAT scans would be advantageous over simple X-ra
   c) Suggest one reason why a doctor might decide to still use X-ray s

6.5.2 Diagnostic methods in med

1. State two isotopes used as medical tracers.

2. Gamma cameras are another means of imaging a patient's body to ob internal structures such as their skeleton, kidneys and liver.
   a) Sketch a diagram of a gamma camera, including labels of its key
   b) Explain how the equipment can be used to image the internal str

3. Illustrate the difference between a CAT scan and a PET scan.

4. Explain how a PET scan operates.

6.5.3 Ultrasound

1. Explain what is meant by the term 'ultrasound'.

2. State the purpose of an ultrasound transducer.

3. Explain how the ultrasound transducer converts between sound and

4. Explain the main differences between an A-scan and a B-scan.

5. Ultrasounds are most commonly used in scans of foetuses. The transd expectant mother's stomach and waves are transmitted into her body
   a) Explain what the ultrasound intensity reflected at the boundary
   b) Calculate the acoustic impedance of air given that air has a densit

   Ultrasound waves travel at 1450 ms^{-1} in fat of density 1000 kgm^{-3}.

   c) Determine the ratio between the intensity of the reflected and tra between the transducer and the mother's stomach.
   d) Explain what your answer to (c) indicates.
   e) Explain how the ratio in (c) could be improved

   Since the transducer is placed on the patient's skin the transducer has the skin above a blood vessel.

   f) Explain why ultrasound waves reflected off the blood cells could received by the transducer from reflected waves.

   During an appointment the doctor places the ultrasound transducer a uses the fact that frequency shifts during the scan to produce a colour indicates speed and direction of the blood flow.

   g) Calculate the speed of the blood flow if the transducers emit an u of 12 MHz and the observed Doppler shift is 1.22 kHz.

   Note: The speed of ultrasound in blood is 1600 ms^{-1}

Preview of Questions Ends Here

Answers

5.1 Thermal physics

1. When two objects are at the same temperature and there is no net flow of the

2. T(K) = θ(°C) + 273
   T(K) = 34 + 273
   T(K) = 307 K (1)

3. T(K) = θ (°C) + 273
   θ(°C) = 348 - 273
   θ(°C) = 75 °C (1)

4. As it refers to the properties of a substance being defined using absolute zero
   system with minimum energy. (1)

5. a)
   - Molecules are **tightly spaced** (1) and **randomly oscillate around a**
   - Molecules are still in contact with each other but are less **tightly sp**
     randomly. (1)
   - Molecules are not in contact with each other (1) and they move sig

   b) Air: negligible electrostatic attraction. (1)
   Mug: strong electrostatic attraction. (1)

6. The molecules gain kinetic energy and, therefore, the speed of the molecules

7. The molecules gain kinetic energy and, therefore, the amplitude of the molec

8. a) Refers to the continuous random motion of small particles that are susp

   b)
   - Smoke particles can viewed in close glass strip illuminated under a
   - The strip can be connected to a video monitor that displays the par
     be seen to move randomly on the screen. (1) (Move with Brownian

9. a) The sum of random distribution of kinetic and potential energies of the

   b) The kinetic energy of the particles would increase and consequently so will

   c) A system will have minimum internal energy when it is at absolute zero

   d) No, a system will always have some internal energy as the particles will
   potential. (1)

10. a) Refers to the process of a substance changing from one state to another.

    b) During the phase change from a solid to a liquid:
    - the temperature is constant and, therefore, the kinetic energy rema
    - the internal energy increases as the potential energy between the m
      spacing increases (1)

    Student needs to provide both answers for full marks.

11. a) $E = mc\Delta T$

    b)
    - Take initial readings of the mass of the water from the scales (weigh be
      beaker mass away to get the mass of the water) and the temperature of
    - Place heater in water and connect it to the voltmeter, ammeter and
      the heater to increase the temperature of the water, noting the volta
      power is supplied for. (1)
    - Use thermometer to measure temperature of the water after heatin
    - Use the readings for the equation $IVt(E) = mc\Delta T$ to determine c. (

c) $c = \frac{E}{m\Delta t}$

$c = \frac{67}{0.7\times19} = 5.03\ \mathrm{Jkg^{-1}\,K^{-1}}$ (1)

d) (1) mark for any of the following:
- Heat loss to surroundings (inaccurate change in temperature)
- Heat loss to beaker (inaccurate change in temperature)
- Systematic errors in meter readings (inaccurate value for thermal e
- Systematic error in scale reading (inaccurate value for mass)

e) If the amount of water and, therefore, mass of the water increased then the water would be less than before as from the equation the change in in order for the other parameters to remain constant. (1)

12. a) The specific latent heat of vaporisation is the energy required to change whereas the specific latent heat of fusion is the energy required to chang

b)
- Place water of known mass into two containers, the inner one is fitt
- Place an electric heater into the water and set it up to a voltmeter a the heater causing the water to boil turning to steam through hole.

c) Full marks (2) for any two suitable answers:
- The water might continue to change state after the power to the he
- The apparatus may heat up and, therefore, need to take their specif (1)
- The water remaining in the container will have heated up. (1)

d) $E = IVt$

$E = mL$

$IVt = mL$

$L = \frac{IVt}{m}$ (1)

$L = \frac{3\times12\times60}{0.9} = 2.4\times10^{3}\ \mathrm{J}$ (1)

5.1.4 Ideal gas

1. A constant that states that there are 6.02×10^{23} molecules in one mole of a sub
OR
Number of atoms in 12 g of carbon-12. (1)

2. $N=nN_a$
$N= 23\times6.02\times10^{23} = 1.38\times10^{25}$ Molecules. (1)

3. Refers to model gas that has no interactions and, therefore, satisfies the gas l

4. $pV = nRT$ (1)
OR
$pV = NkT$ (1)

5. $T = \frac{pV}{Nk}$

$T = \frac{1.04\times10^{5}\times0.32}{(2.58\times10^{25}\times1.38\times10^{23})} = 93\ \mathrm{K}.$ (1)

6. It is assumed for an ideal gas that the potential energy is negligible; therefore the mean kinetic energies of all the molecules in the gas. (1)

7. The theory refers to the study of the microscopic properties of gas molecules properties apparent in the ideal gas laws. (1)

8. The four assumptions of the kinetic theory of gases:
   - Particles occupy negligible volume compared to the volume of the gas.
   - There are negligible forces between particles expected during collision.
   - All collisions between particles are perfectly elastic and the time of colli the time between collisions. (1)
   - Gases comprise a large number of molecules in random, rapid motion.

9. - Gas molecules collide with each other and the walls of the container; th therefore, no kinetic energy and no speed is lost during collisions. (1)
   - Each gas molecule experiences a change in momentum and exerts a forc since the kinetic theory states that there is a large number of molecules, container at a macroscopic level, it translates to [illegible]ure exerted on the

10. a) Pressure is inversely proportio[illegible]lume for fixed mass of gas at cor
    b)
       - Fill a container, of [illegible]ame, with gas and completely subme filled bea[illegible]d to a heater. (1)
       - [illegible]n [illegible]essure gauge to the container to measure the pressure [illegible]mometer into the beaker of water. (1)
       - In order to see how the parameters relate, increase the temperature of the temperature on the thermometer and the corresponding pres
    c) The **kinetic energy** and, therefore, the **speed** of the molecules **increases** and the volume remaining constant, **the number of collisions per secor** the **force** exerted on the wall increases and from the equation $P = \frac{F}{A}$ the
    d) $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1)

       $P_2 = \frac{P_1}{T_1} \times T_2 = 1.3 \times 10^5$ Pa. (1)
    e) Extrapolate the straight line so it cuts the x-axis to give an estimated val
    f) $N = nN_a$ (1)

       $N = 7 \times 6.02 \times 10^{23} = 4.21 \times 10^{24}$ molecules. (1)
    g) $pV = \frac{1}{3} Nm\overline{c^2}$ (1)

       $\overline{c^2} = \frac{3pV}{Nm} = \frac{3 \times 1.12 \times 10^5 \times 0.98}{(4.21 \times 10^{24}) \times (2.32 \times 10^{-26})} = 3.37 \times 10^6$

       $c_{rms} = 1.84 \times 10^3 \text{ ms}^{-1}$ (1)

11. a) $pV = NkT$; $pV = \frac{1}{3} Nm\overline{c^2}$ (1)

       Therefore

       $NkT = \frac{1}{3} Nm\overline{c^2}$

       $kT = \frac{1}{3} m\overline{c^2}$ (1)

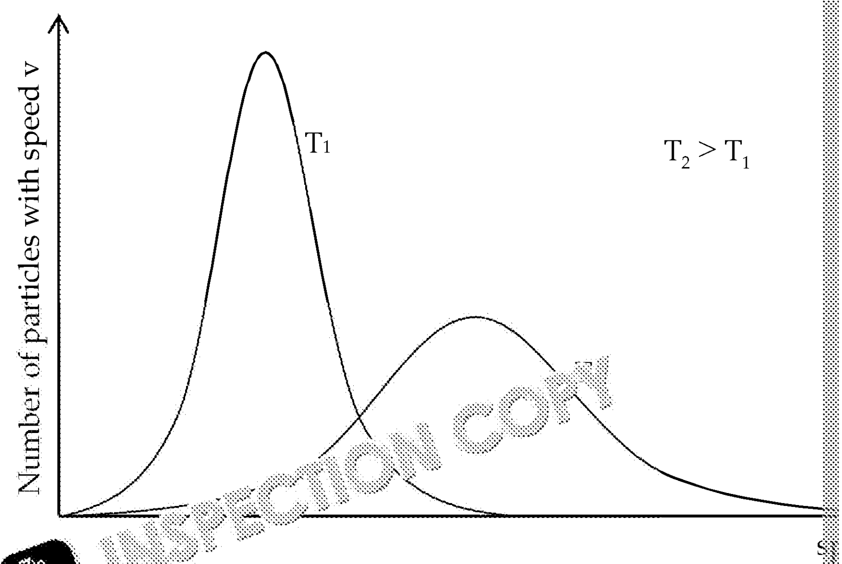
       If both sides are multiplied by $\frac{3}{2}$:

       $\frac{1}{2} m\overline{c^2} = \frac{3}{2} kT.$ (1)
    b) $\frac{1}{2}$ [illegible] $\frac{3}{2}k$

       1.4[illegible]$^{22} = \frac{3}{2} kT$ (1)

       $T = \frac{\frac{2}{3} \times 1.45 \times 10^{-20}}{1.38 \times 10^{-23}} = 700$ K (1)
    c) If the temperature is greater, the kinetic energy will be greater. (1)

d) (1) mark for correct sketch of curve lower in height and with a wider spread.



5.2 Circular motion

1. The angle subtended when the arc length is equal to the radius. (1)

2. $35\,° = \frac{7\pi}{36}$ (1) ; $270\,° = \frac{3\pi}{2}$ (1)

3. $\frac{5\pi}{3} = 300\,°$ (1); $3\pi = 540°$ (1)

4. The time taken to complete one revolution. (1)

5. The number of complete revolutions per second. (1)

6. a) $\omega = \frac{2\pi}{T}$ (1)
   $T = \frac{2\pi}{w} = \frac{2\pi}{4.3} = 1.46$ s (1)
   b) $f = \frac{1}{T}$ (1)
   $f = \frac{1}{1.46} = 0.68$ Hz (1)
   OR
   $\omega = 2\pi f$ (1)
   $f = \frac{\omega}{2\pi} = \frac{4.3}{2\pi} = 0.68$ Hz (1)

7. a) An object will remain in a circular path if a constant net force is applied
   motion (centripetal force). (1)
   b) The gravitational force of the Earth on the Moon acts as the centripetal f
   c) T = 27 days
   T = 27 × 24 × [illegible] 32 800 s (1)
   ω [illegible])
   $\omega = \frac{2\pi}{2332800} = 2.69 \times 10^{-6}$ rads^{-1} (1)
   d) The linear velocity remains constant during circular motion. (1)
   e) The Moon would continue travelling in a straight line at a constant line
   external force. (1)
   f) $v = rw$ (1)
   $v = (4.6 \times 10^{6} \times 2.69 \times 10^{-6} = 12.37$ ms^{-1} (1)

8. a) The centripetal force originates from the force of friction from the tyres

b) $F = \frac{mv^2}{r}$ (1)

$F = \frac{900 \times 11.6^2}{8 \times 10^3} = 15.1$ N (1)

c) $F = \frac{mv^2}{r}$; $F = ma$ (1)

$ma = \frac{mv^2}{r}$

$a = \frac{v^2}{r}$ (1)

d) The direction of acceleration is always in the direction of the force (1) a
centripetal acceleration is towards the centre of the circular path. (1)

e) $a = \frac{v^2}{r}$

$a = \frac{11.6^2}{8 \times 10^3} = 0.02$ ms^{-2} (1)

Alternatively,

$a = \frac{F}{}$

a [illegible] 0.02 ms^{-2} (1)

9. a)
- Measure the length of the string and the mass of a rubber bung. (1)
- Tie the string to a rubber bung and attach the other end of a know
round in a horizontal circle. (1)
- Measure the time it takes to complete N number of rotations with
- The linear speed can be worked out from $v = \frac{2\pi r}{T}$ and $F = \frac{mv^2}{r}$.(1)

b) $T = 3 \times 1 = 3$ s (1)

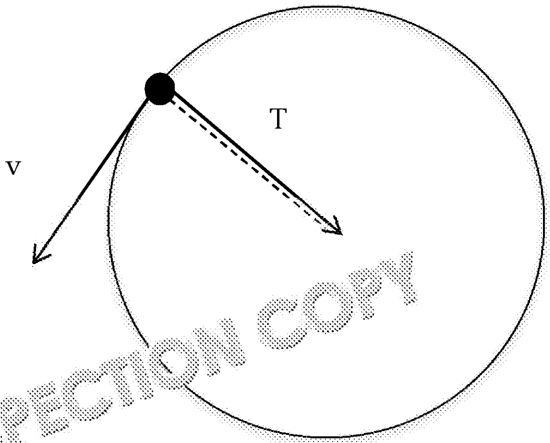
c) $a = \omega^2 r$ (1)

$\omega = \frac{2\pi}{T} = \frac{2\pi}{3} = 2.09$ rads^{-1} (1)

$a = 2.09^2 \times 0.8 = 3.49$ ms^{-2} (1)

d) Tension in the string. (1)

e) (1) mark for each label.



f) If [illegible]gth of string and, therefore, radius of the circular path was red
- the period of rotation would decrease (1)

OR
- the angular velocity of the rubber bung would increase (1)