Government of **Western Australia**
**School Curriculum and Standards Authority**

# SAMPLE ASSESSMENT TASKS

## PHYSICS
## ATAR YEAR 12

# Sample assessment task

## Physics – ATAR Year 12

### Task 1 – Unit 3

**Assessment type:** Science inquiry – Investigation

**Conditions**
One lesson for planning, one lesson for conducting as a group member
One lesson for processing and evaluation to be completed under test conditions

**Task weighting**
5% of the school mark for this pair of units

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**Investigation of motion on an inclined plane** **(38 marks)**

Design an investigation to determine how a factor influences acceleration down a ramp.

Decide which factor you are going to investigate. Some ideas are mass, angle of slope, friction.

You will need to decide which measurements you are going to make, and how you will calculate acceleration and force.

You could use trolleys, model cars, skateboards, rollerblades or bicycles.

**Planning and conducting** (18 marks)

Write the hypothesis that you will investigate. This should include a relationship between the dependent and independent variables.

Conduct some preliminary trials and record how you will modify your procedure to ensure that controlled variables are kept the same.

Write your method, including how you will take your measurements.

Conduct the investigation, recording all data in an appropriate table.

**Processing** (16 marks)

Process the data and show all working out to calculate average speed and acceleration.

Draw a graph of your results.

Draw a vector diagram to show the forces acting on the body.

Calculate the force accelerating the body down the ramp for each change of condition in your experiment, e.g. for each angle of the ramp.

For one condition, compare the theoretical force down the slope (the component of gravity) with the actual force (your experimental value). Calculate the percentage error in your result and comment on it.

Write your conclusion and relate it to your hypothesis.

**Evaluation** (4 marks)

Discuss the sources of error or uncertainty in your results, and suggest modifications which could improve the results in future investigations.

# Marking key for sample assessment task 1 – Unit 3

Investigation of motion on an inclined plane

| Description | Marks |
|---|---|
| **Planning and Conducting** | **/18** |
| Develops a clear hypothesis which relates the independent and dependent variables | 1–2 |
| Lists all materials required | 1–3 |
| Identifies controlled variables | 1–2 |
| Clearly lists the procedure/method to be used | |
| • clearly describes equipment and how it is set up | 1 |
| • describes how trials are to be conducted in a clear logical manner | 1 |
| • description of method allows for investigation to be repeated by others | 1 |
| • states which measurements are to be collected | 1 |
| • plans for repeat trials | 1 |
| Shows a labelled diagram or photograph of equipment set-up | 1–2 |
| Collects full and accurate results | 1–2 |
| Displays data in suitable table | 1–2 |
| **Processing** | **/16** |
| Averages data from repeat trials | 1 |
| Calculates average speed and acceleration correctly where appropriate | 1–2 |
| Displays data in suitable graph | |
| • title | 1 |
| • labelled axes with units | 1 |
| • data correctly plotted | 1 |
| • line of best fit drawn | 1 |
| Draws a vector diagram showing forces on the body | |
| • shows $g$ as hypotenuse of triangle | 1 |
| • two other vectors correctly shown | 1–2 |
| Calculates theoretical force acting to accelerate body down ramp | |
| • $a = g \sin\theta$ | 1 |
| • calculates value | 1 |
| Calculates difference between theoretical force and actual force | 1 |
| Calculates percentage uncertainty | 1 |
| States a conclusion and relates it to the hypothesis | 1–2 |
| **Evaluation** | **/4** |
| Discusses sources of error or uncertainty in the data | 1–2 |
| Makes reasonable suggestions for improvements to procedure | 1–2 |
| **Total** | **/38** |

# Sample assessment task

## Task 4 – Unit 3

**Assessment type:** Test

**Conditions**
Time for the task: 50 minutes
Completed in class under test conditions

**Task weighting**
8% of the school mark for this pair of units

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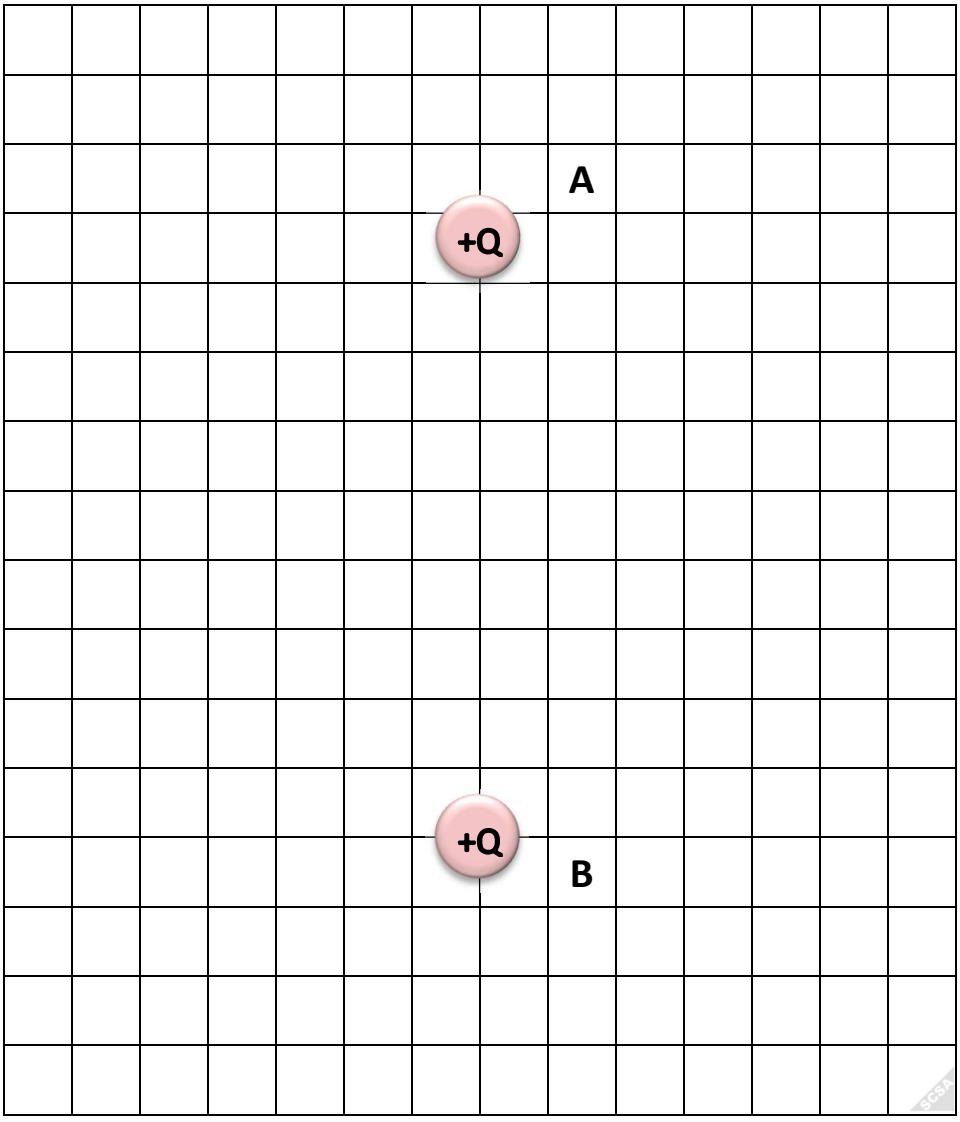
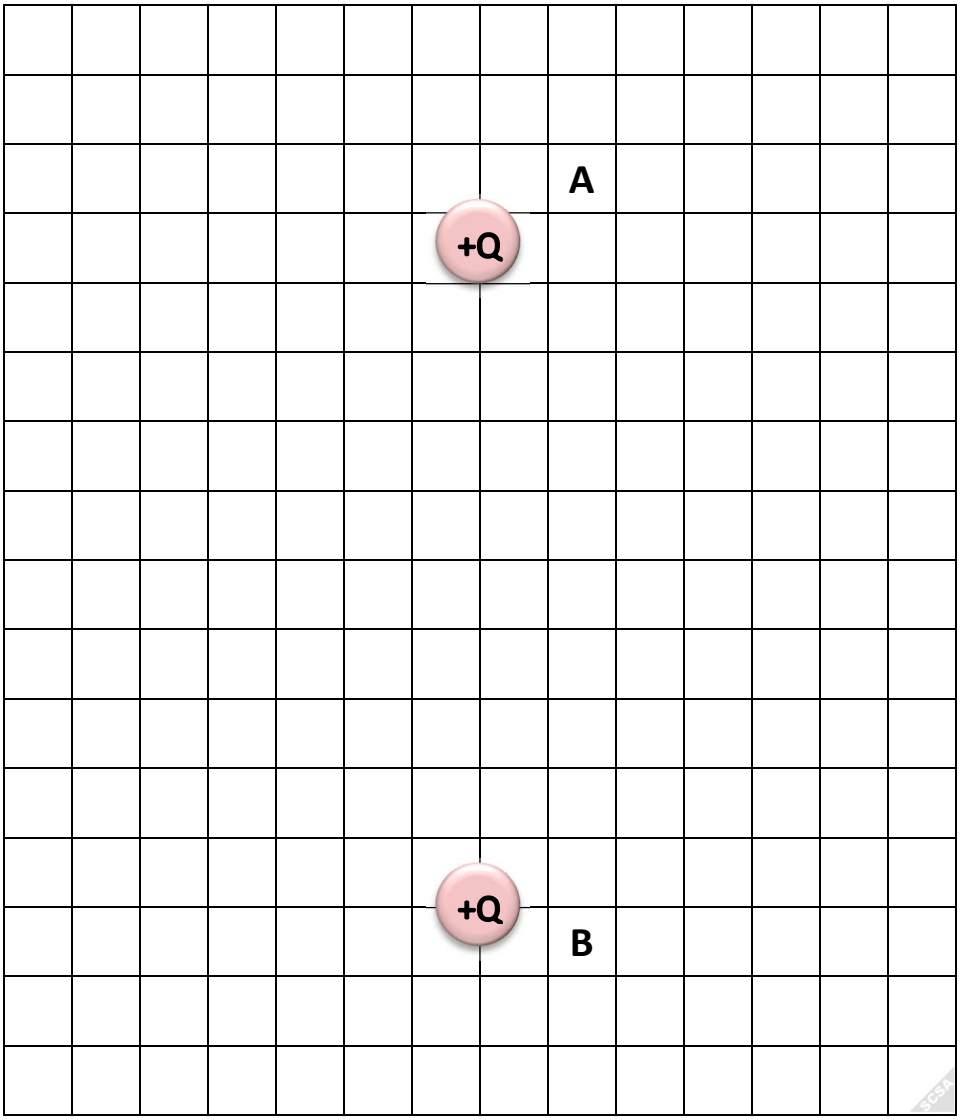
**Electromagnetism test** **(56 marks)**

**Question 1** **(17 marks)**
A and B are two identical, very small particles which both have a charge of +Q. They are fixed in position 10 units apart.

(a) On the diagram below, draw the resultant electric field around the charged particles. (3 marks)



(b) C and D are two particles with identical mass and volume to A and B, but they have a charge of -Q. Draw particles C and D on the diagram below so that the four particles will be in static equilibrium. (3 marks)




(c) On the diagram above, draw and label **three** arrows on particle C to indicate the forces acting on particle C due to the other three particles. (3 marks)

(d) If a charged particle with a charge of 2.40 nC is placed in an electric field with a strength of $9.80 \times 10^{-4}$ N $C^{-1}$, calculate the force it will experience. (2 marks)

(e) Two particles with charges of + 3.00 nC and – 2.00 nC are suspended 4.00 mm apart. If the distance between them is trebled (x3), by what factor will the force between them change? (2 marks)

(f) If the charged particles attract each other and touch, explain what will happen next, including the final charge on each particle. (4 marks)

**Question 2** **(3 marks)**

A householder is trying to decide if solar panels are suitable energy sources for her house. Measurements of the current demand for the house show that a minimum current of 12.5 A is needed. The useable roof area of the house is found to be 180 $m^2$.

If the best solar panel is capable of converting solar energy to electricity at the rate of 45.0 W $m^{-2}$, at a voltage of 240 V, will it be possible to use these solar panels to power the house?

**Question 3** **(4 marks)**

A 0.75 m vertical aerial is located on the roof of a car and is insulated from the car. The car is travelling east at 60.0 km $h^{-1}$, in a region near Perth where the horizontal component of the earth's magnetic field is 2.50 x $10^{-5}$ T.

(a) Calculate the emf induced in the aerial. (3 marks)

(b) Which end of the aerial is at a positive potential? (1 mark)

**Question 4** **(8 marks)**

Pylons supporting high voltage (e.g. 500 kV) power cables tend to be very tall and located away from populated areas.

(a) Give **two** reasons why high voltage AC power cables are usually located away from populated areas. (2 marks)

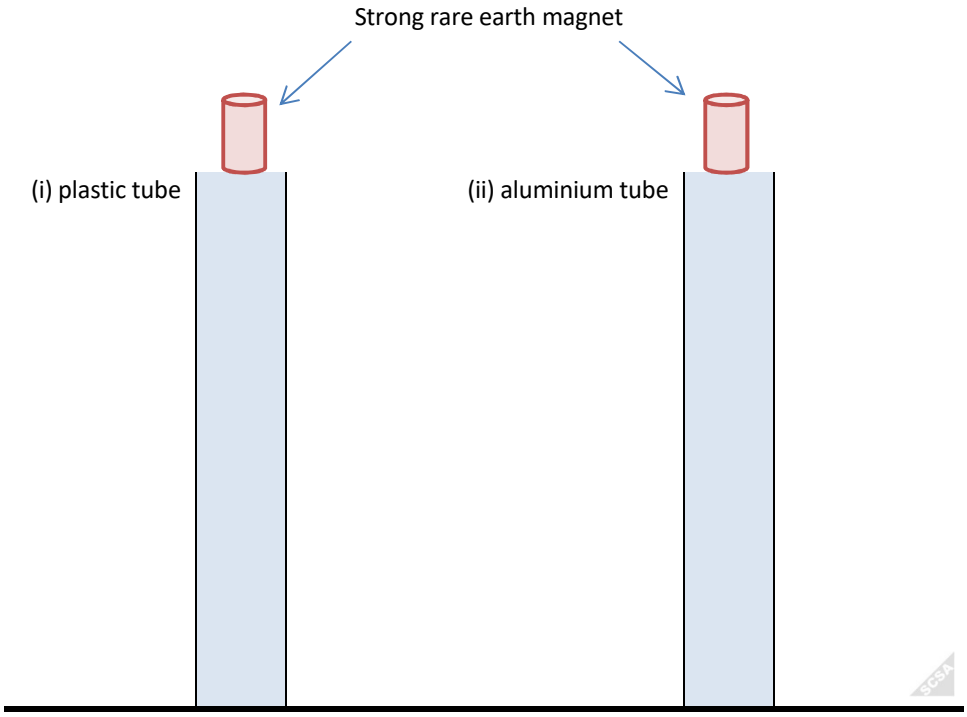
(b) Explain why electrical power is transmitted at very high voltages, such as 500 kV. (4 marks)

(c) Occasionally, when you are driving a car under or near high voltage cables, you will notice considerable interference on your car radio. Explain why this interference occurs. (2 marks)

**Question 5** **(4 marks)**

A physics teacher set up the equipment shown below.

One tube is made of plastic and the other is aluminium. The students dropped a strong rare earth permanent magnet down each tube at the same time.




The magnet falling through the plastic tube travelled much faster than the magnet falling through the aluminium tube. Explain, clearly indicating the physics principles involved.

**Question 6** **(20 marks)**

(a) A DC motor can be made using a coil on an axle, two magnets and a power source. When this equipment is set up properly, the coil rotates on the axle. Draw a diagram showing a simple motor. (3 marks)

(b) Explain why the coil rotates. (3 marks)

(c) A coil has a length of 0.100 m and a width of 0.0800 m and has 30.0 turns. A current of 4.00 A flows through the coil and it is in a uniform magnetic field of 0.010 T. Calculate the force on one side of the coil. (3 marks)

(d) Using information from part (c), determine the torque acting on the coil. (2 marks)

(e) Describe **three** modifications you could make to the equipment to make the coil rotate more quickly. (3 marks)

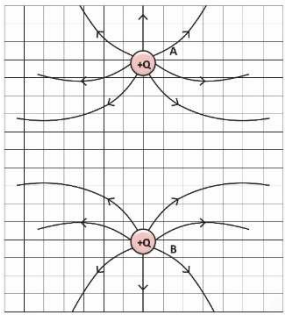
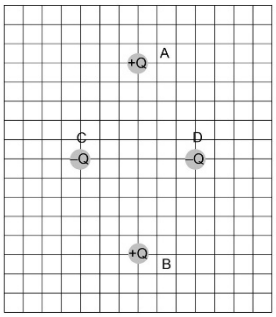
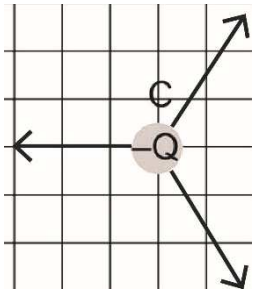
(f) Most electric motors have more than one coil. Explain how this improves the performance of the motor. (3 marks)

(g) Name **three** household devices that contain an electric motor. (3 marks)

# Marking key for sample assessment task 4 – Unit 3

**Electromagnetism test** **(56 marks)**

1. (a) On the diagram below, draw the resultant electric field around the charged particles.
   (b) Draw particles C and D on the diagram below so that the four particles will be in static equilibrium.
   (c) Draw and label **three** arrows on particle C to indicate the forces acting on particle C due to the other three particles.
   (d) If a charged particle with a charge of 2.40 nC is placed in an electric field with a strength of $9.80 \times 10^{-4}$ $NC^{-1}$, calculate the force it will experience.
   (e) Two particles with charges of + 3.00 nC and – 2.00 nC are suspended 4.00 mm apart. If the distance between them is trebled (x3), by what factor will the force between them change?
   (f) If the charged particles attract each other and touch, explain what will happen next, including the final charge on each particle.

| Description | Marks |
|---|---|
| (a) draws at least four lines in correct pattern | 1 |
| lines do not cross | 1 |
| arrows in correct direction | 1 |
|  | |
| (b) particles have negative charge<br>particles are equidistant from A and B<br>particles are equidistant from midline<br>  | 1–3 |
| (c) draws two arrows towards A and B and one arrow away from D<br>  | 1–3 |

| | |
|---|---|
| (d) $E = F/q$ so $F = Eq$<br>$F$ = 2.40 x $10^{-9}$ x9.80 x $10^{-4}$<br>= 2.35 x $10^{-12}$ N | 1–2 |
| (e) $r^2$ = x9<br>factor = 1/9 | 1–2 |
| (f) the charge will spread across the two particles<br>since they are both positive<br>they will repel<br>each has a charge of 0.50 nC | 1<br>1<br>1<br>1 |
| **Total** | **17** |

2. If the best solar panel is capable of converting solar energy to electricity at the rate of 45.0 W $m^{-2}$, at a voltage of 240 V, will it be possible to use these solar panels to power the house?

| Description | Marks |
|---|---|
| Panel: $P = VI$ = 240 x 12.5<br>$P$ = 3.00 x $10^3$ W | 1 |
| Available $P$ = area x rate = 180 x 45.0<br>= 8.10 x $10^3$ W | 1 |
| Yes, it is possible | 1 |
| **Total** | **3** |

3. (a) Calculate the emf induced in the aerial.
   (b) Which end of the aerial is at a positive potential?

| Description | Marks |
|---|---|
| (a) $v$ = 60 $kmh^{-1}$ = 16.7 $ms^{-1}$ | 1 |
| emf = $Blv$ = 2.50 x $10^{-5}$ x 0.75 x 16.7<br>= 3.13 x$10^{-4}$ V | 1<br>1 |
| (b) top | 1 |
| **Total** | **4** |

4. (a) Give **two** reasons why high voltage AC power cables are usually located away from populated areas.
   (b) Explain why electrical power is transmitted at very high voltages, such as 500 kV.
   (c) Occasionally, when you are driving a car under or near high voltage cables, you will notice considerable interference on your car radio. Explain why this interference occurs.

| Description | Marks |
|---|---|
| (a) to reduce the risk to people's health of a large oscillating magnetic field<br>or to protect electrical devices in homes<br>or aesthetics | 1–2 |
| (b) since $P = VI$<br>if $V$ is high, $I$ is low<br>therefore less power is lost<br>power lost = $I^2R$ | 1<br>1<br>1<br>1 |
| (c) the varying magnetic fields around the cables can induce current in the cables<br>and these currents can be amplified and heard as noise | 1<br>1 |
| **Total** | **8** |

5. Explain, using physics principles, why the magnet falling through the plastic tube travelled much faster than the magnet falling through the aluminium tube.

| Description | Marks |
|---|---|
| current induced in the aluminium tube due to changing magnetic flux | 1 |
| motion produces a magnetic field in aluminium tube only | 1 |
| the field acts to oppose the motion of the magnet so it falls slower<br>Lenz's law | 1–2 |
| **Total** | **4** |

6. (a) A DC motor can be made using a coil on an axle, two magnets and a power source. When this equipment is set up properly, the coil rotates on the axle. Draw a diagram showing a simple motor.
   (b) Explain why the coil rotates.
   (c) The coil has a length of 0.100 m and a width of 0.0800 m and has 30.0 turns. A current of 4.00 A flows through the coil and it is in a uniform magnetic field of 0.010 T. Calculate the force on one side of the coil.
   (d) Using information from part (c), determine the torque acting on the coil.
   (e) Describe **three** modifications you could make to the equipment to make the coil rotate more quickly.
   (f) Most motors have more than one coil. Explain how this improves the performance of the motor.
   (g) Name **three** household devices that use an electric motor.

| Description | Marks |
|---|---|
| (a) coil, magnets, power source correctly shown | 1–2 |
| brushes included | 1 |
| (b) magnetic field acts on current in wire | 1 |
| produces force | 1 |
| force rotates coil | 1 |
| (c) $F = BIl$<br>= 0.010 x 4.00 x 30 x 0.100<br>$F$ = 0.12 N | 1<br>1<br>1 |
| (d) $\tau = rF$ = 0.0400 x 0.120 = 4.80 x $10^{-3}$ Nm | 1–2 |
| (e) more coils, higher current, stronger magnets, magnets closer to coil | 1–3 |
| (f) maximum force is generated when wire moves perpendicular to magnetic field<br>with more than one coil there is more time when maximum force is generated<br>this provides a smoother rotation of the armature | 1<br>1<br>1 |
| (g) any appliance with moving parts – washing machine, microwave turntable, fan etc. | 1–3 |
| **Total** | **20** |

# Sample assessment task

## Physics – ATAR Year 12

### Task 7 – Unit 4

**Assessment type:** Science inquiry – Evaluation and analysis

**Conditions**
Time for the task: 50 minutes plus preparation time
Access to the articles and the Formulae and Data booklet
Test conditions

**Task weighting**
5% of the school mark for this pair of units

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**Quantum theory and special relativity** **(38 marks)**

**Preparation**

View the clip *How to make Quark Soup*
http://www.youtube.com/watch?v=o9mw75xX2YE&feature=youtu.be

Quark gluon plasma video clip
https://www.youtube.com/watch?v=Rk9KZLaVItI

Class discussion of the video clips.

At home, read the following articles:

1. 'Perfect' liquid hot enough to be quark soup
   http://www.sciencedaily.com/releases/2010/02/100215101014.htm

2. Synchrotron
   http://archive.synchrotron.org.au/about-us/our-facilities/accelerator-physics/synchrotrons-and-the-large-hadron-collider

3. Synchrotron light
   https://www.ansto.gov.au/education/nuclear-facts/what-is-synchrotron-light

You may access the articles during the in-class task.

Using your understanding of physics concepts and the information from the sources, answer the following questions. You may have a copy of the articles and the Formulae and Data booklet.

**Question 1** **(10 marks)**

(a) Use information from *How to make Quark Soup* to describe what happens when the gold ions collide. (3 marks)

(b) Why do scientists think that the quark-gluon plasma is acting as a fluid rather than a gas? (2 marks)

(c) What is meant by the term 'a perfect fluid'? (1 mark)

(d) What happens to a proton when it melts? (2 marks)

(e) According to the article, the high temperature is reached in less time than it takes for light to travel across a single proton. Calculate this time given that the radius of a proton is 0.8768 fm (femtometre = $10^{-15}$ m) (2 marks)

**Question 2** **(5 marks)**

(a) Explain what is meant by 'mass-energy equivalence'. (3 marks)

(b) Compare the energy equivalent of an electron travelling at 99.9997% the speed of light with that of an electron at rest. Refer to the equation below. (2 marks)

$$E = \frac{m c^2}{\sqrt{1-\frac{v^2}{c^2}}}$$

**Question 3** **(13 marks)**

(a) With reference to the equation $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$, explain why, as the speed of the electron increases, it becomes more difficult to accelerate. (4 marks)

(b) Explain why the LHC has a much larger circumference than the Australian synchrotron.

Refer to the equation $r = \frac{mv}{qB}$ in your answer. (5 marks)

(c) Discuss why the light given off in particle accelerators is useful to science. (4 marks)

**Question 4** **(10 marks)**

(a) Use your understanding of electromagnetism to explain how a magnetic field accelerates the particles in a particle accelerator. (3 marks)

(b) Use your understanding of electromagnetism to explain how an electric field accelerates the particles in a particle accelerator. (3 marks)

(c) How do scientists use the LHC to investigate the beginning of the universe? (4 marks)

## Marking key for sample assessment task 7 – Unit 4

1. (a) Describe what happens when the gold ions collide.
   (b) Why do scientists think that the quark-gluon plasma is acting as a fluid rather than a gas?
   (c) What is meant by the term 'a perfect fluid'?
   (d) What happens to a proton when it melts?
   (e) According to the article, the high temperature is reached in less time than it takes for light to travel across a single proton.
   Calculate this time given that the radius of a proton is 0.8768 fm (femtometre = $10^{-15}$ m).

| Description | Marks |
|---|---|
| (a) extremely high temperatures occur<br>the high temperature melts the protons<br>quarks and gluons separate out | 1–3 |
| (b) the particles do not act independently as gas particles do<br>the particles exert a force on each other as liquid particles do | 1–2 |
| (c) no viscosity or frictional resistance | 1 |
| (d) it separates out into its 3 quarks and gluons | 1-2 |
| (e) $t = s/v$ = 2 x 0.8768 x $10^{-15}$/3 x $10^{8}$<br>= 5.85 x $10^{-24}$ s | 1–2 |
| **Total** | **10** |

2. (a) Explain what is meant by 'mass-energy equivalence'.
   (b) Compare the energy equivalent of an electron travelling at 99.9997% the speed of light with that of an electron at rest.

| Description | Marks |
|---|---|
| (a) mass and energy can be viewed as interchangeable/mass can be converted to energy<br>energy can provide mass (in the case of gluons)<br>the relating conversion factor is $c^2$, as in $E=mc^2$ | 1–3 |
| (b) When $v$ = 0.999997 c, $E = mc^2$ /√1-0.999997$^2$<br>so $E$ = 408 $mc^2$ | 1–2 |
| **Total** | **5** |

3. (a) With reference to the equation $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$, explain why, as the speed of the electron increases, it becomes more difficult to accelerate.

   (b) Explain why the LHC has a much larger circumference than the Australian synchrotron. Refer to the equation $r = \frac{mv}{qB}$ in your answer.

   (c) Discuss why the light given off in particle accelerators is useful to science.

| Description | Marks |
|---|---|
| (a) as v gets closer to c, $v^2/c^2$ becomes closer to 1<br>when $m_0$ is divided by a number that is approaching zero,<br>$t$ becomes much larger<br>when m is very large, it requires a larger force to accelerate it. | 1–4 |
| (b) The LHC is accelerating protons which are much heavier than electrons<br>Since $m$ is larger $r$ must be larger for same velocity ($q$ is the same)<br>as the particles get closer to speed of light, their mass increases<br>either the magnetic field must be increased<br>or the radius of accelerator must increase<br>increasing $B$ is expensive | 1–5 |
| (c) it is very intense, so provides high resolution images<br>It can be tuned to any frequency<br>It is produced in very short pulses which enables time measurement<br>It can be polarised in a particular direction | 1–4 |
| **Total** | **13** |

4. (a) Use your understanding of electromagnetism to explain how a magnetic field accelerates the particles in a particle accelerator.

   (b) Use your understanding of electromagnetism to explain how an electric field accelerates the protons in a particle accelerator.

   (c) How do scientists use the LHC to investigate the beginning of the universe?

| Description | Marks |
|---|---|
| (a) Magnetic field accelerates charged particle by exerting a force<br>Force is perpendicular to its velocity which changes its direction<br>Resulting in a circular path | 1–3 |
| (b) electric fields increase the speed of the proton<br>proton is attracted towards negative charges<br>protons are repelled from positive charges | 1–3 |
| (c) High temperatures caused by particle collisions<br>Cause plasma to form<br>Matter breaks down into quarks and gluons<br>They can then observe how matter forms as it would have in the beginning | 1–4 |
| **Total** | **10** |