Mark Scheme (Results)

January 2026

Pearson Edexcel International Advanced level In Physics
Further Mechanics, Fields and Particles
WPH14/01A

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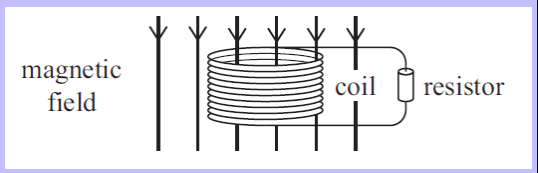
General Marking Guidance

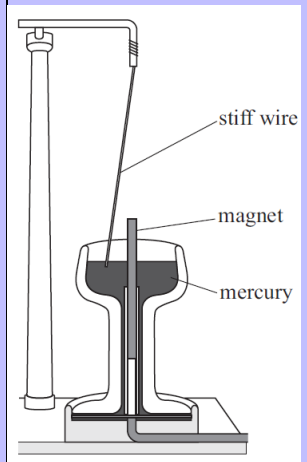
- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

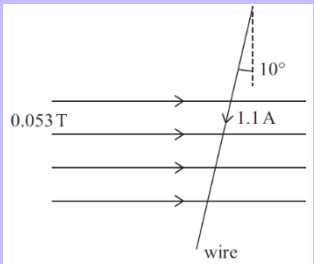
Question Number	Answer	Mark
	A neutron can decay to produce a proton. **Which of the following equations correctly shows neutron decay?**	
1	**The only correct answer is C** ($n \rightarrow p + e^{-} + \bar{\nu}_e$) A is not correct because charge is not conserved B is not correct because neither charge nor lepton number are conserved D is not correct because lepton number is not conserved	**1**
	A ball of mass *m* travelling with velocity *v* strikes a wall at right angles. It bounces off the wall in the opposite direction at the same speed. **Which of the following is the impulse on the wall?**	
2	**The only correct answer is B** ($2mv$) as the change in momentum of the ball is $-mv - (mv) = -2mv$, and so the wall must have $2mv$ to conserve momentum A is not correct because the ball rebounds C is not correct because the direction is wrong D is not correct because the direction is wrong	**1**
	In an electron deflection tube, electrons are released by passing a current through a metal filament. **What is the name of the process that releases the electrons?**	
3	**The only correct answer is D** (thermionic emission) A is not correct because no electrons are diffracted B is not correct because the electrons emitted are free electrons in the metal, not atomic electrons C is not correct because incident photons are the cause of the photoelectric effect	**1**
	A potential difference of 0.2 V is applied across parallel plates with a separation of 4 cm. **What is the electric field strength halfway between the plates, in units of V m^{-1}?**	
4	**The only correct answer is C** $(5) = 0.2/0.04$ A is not correct because cm have not been converted to m B is not correct because cm not converted to m, and have used half the distance, even though the field is uniform D is not correct because half the distance has been used even though the field is uniform	**1**
	A particle of mass *m* has momentum *p* and kinetic energy E_k. A second particle of mass *m*/2 has momentum 2*p*. **What is the kinetic energy of the second particle?**	
5	**The only correct answer is D** ($8E_k$) A is not correct because $E_k = \frac{p^2}{2m}$ and so doubling momentum while having mass leads to an eightfold increase in kinetic energy B is not correct because $E_k = \frac{p^2}{2m}$ and so doubling momentum while having mass leads to an eightfold increase in kinetic energy C is not correct because $E_k = \frac{p^2}{2m}$ and so doubling momentum while having mass leads to an eightfold increase in kinetic energy	**1**

	A particle has a mass of 3.17×10^{-27} kg. Which of the following gives the mass in GeV/c^2 ?	
6	**The only correct answer is D** ($\frac{3.17\times10^{-27}\times(3.00\times10^{8})^{2}}{10^{9}\times1.6\times10^{-19}}$) A is not correct because $E = mc^2$ but they have divided by the speed of light B is not correct because $E = mc^2$ but they have divided by the speed of light squared C is not correct because they have not converted eV to GeV	**1**
	A charged capacitor is connected across a resistor of resistance *R* and the current in the resistor is measured. A graph of ln (current) against time is plotted and the gradient of the graph is determined. Which of the following gives the capacitance of the capacitor?	
7	**The only correct answer is B** ($-\frac{1}{gradient\times R}$) A is not correct because $gradient = -1/RC$ does not rearrange to give that expression C is not correct because $gradient = -1/RC$ does not rearrange to give that expression D is not correct because $gradient = -1/RC$ does not rearrange to give that expression	**1**

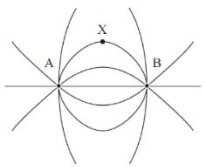
	A particle accelerator produces a beam of very high energy protons. Which of the following statements describes the speed of a proton as it passes through the accelerator?	
8	**The only correct answer is B** (It never reaches the speed of light.) A is not correct because the speed increase is not uniform C is not correct because it never reaches the speed of light D is not correct because speed does not decrease; it is the acceleration that decreases	**1**
	A coil of wire is connected to a resistor, as shown. The magnetic flux density of the field through the coil is increased steadily from zero to a maximum value.  **Which of the following single changes would result in a smaller current in the resistor?**	
9	**The only correct answer is D** (increasing the time taken to reach the maximum flux density) because $I = \varepsilon/R$ and $\varepsilon = \frac{\Delta(BAN)}{\Delta t}$ so increasing Δt would increase current A is not correct because $I = \varepsilon/R$ and $\varepsilon = \frac{\Delta(BAN)}{\Delta t}$ so increasing A would increase current	**1**

	B is not correct because $I = \varepsilon/R$ and $\varepsilon = \frac{\Delta(BAN)}{\Delta t}$ so increasing B would increase current C is not correct because $I = \varepsilon/R$ and $\varepsilon = \frac{\Delta(BAN)}{\Delta t}$ so increasing N would increase current	
	The structure of nucleons can be investigated using electrons with high energies. **Which of the following is the reason why high energies are required?**	
10	**The only correct answer is D** (to produce shorter de Broglie wavelengths) A is not correct because no new particles are created B is not correct because electrons are negatively charged and nucleons are either positive or neutral, so there is either attractive electrostatic force or no electrostatic force C is not correct because the particles involved are stable, so it is irrelevant	**1**

Question Number	Answer	Additional Guidance	Mark
	In 1821, Michael Faraday made what is believed to be the first electric motor, as shown below.  **The stiff wire was suspended freely from a stand. The mercury completed an electrical circuit, which included the wire. When there was a current in the wire, the wire moved around the magnet.** **(a) The wire made 10 complete revolutions around the magnet in a time of 8.3 s.** **Calculate the angular velocity of the wire.**		
11(a)	• Calculate period = 8.3 s ÷ 10 = 0.83 s (1) • Use of $T = 2\pi / \omega$ (1) • $\omega = 7.6$ radian s^{-1} (1)	Example of calculation $T = 8.3$ s ÷ 10 = 0.83 s $\omega = 2\pi / 0.83$ s $\omega = 7.57$ radian s^{-1} Alternative calculation Calculate $f = 10 / 8.3$ s = 1.2 s^{-1} $\omega = 2\pi f = 2\pi \times 1.2$ s^{-1} $\omega = 7.57$ radian s^{-1}	3

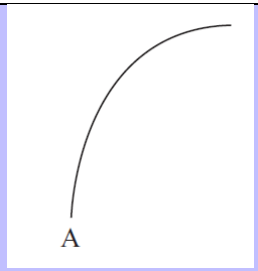
	(b) When the current in the wire is 1.1 A, the wire is at an angle of 10° to the vertical. **The length of the wire in the horizontal magnetic field is 3.5 cm.**  • **Determine the force on the wire.** **magnetic flux density = 0.053 T**		
11(b)	• Use of $F = BIl$ (1) • Use of $F = BIl \sin\theta$ with correct angle (1) • $F = 2.0 \times 10^{-3}$ N (1)		3
	Total for question 11		**6**

Question Number	Answer	Additional Guidance	Mark
	DART is a spacecraft sent to collide with an asteroid on course for Earth. After colliding with one another, DART and the asteroid will stick together. DART will have a speed of 6250 m s^{-1} when it collides with the asteroid. This causes a change in the asteroid's speed of 0.40 mm s^{-1}. **(a) Determine the combined mass of DART and the asteroid.** **mass of DART = 300 kg**		
12 (a)	Use of $p = mv$ (1) Use of principle of conservation of momentum (momentum lost by DART = momentum gained by asteroid) (1) $m = 4.7 \times 10^9$ (kg) (1)	Example of calculation $p = 300 \text{ kg} \times 6250 \text{ m s}^{-1}$ $= 1\,875\,000 \text{ kg m s}^{-1}$ Δp for asteroid = 1 875 000 kg m s^{-1} $m = 1\,875\,000 \text{ kg m s}^{-1} / 0.0004 \text{ m s}^{-1}$ $m = 4.7 \times 10^9$ kg	**3**
	(b) DART collides at 90° to the direction of the asteroid's velocity. The asteroid is moving at a speed of 0.16 m s^{-1}. **Calculate the angle through which the velocity of the asteroid is deflected.**		
12 (b)	Use of tan θ = momentum of DART ÷ momentum of asteroid **Or** use of tan θ = change in velocity of asteroid ÷ original velocity of asteroid (1) $\theta = 0.14°$ (allow ecf from (a)) (1)	Example of calculation $\tan\theta = 0.0004 \text{ m s}^{-1} / 0.16 \text{ m s}^{-1}$ $\tan\theta = 2.5 \times 10^{-3}$ $\theta = 0.14°$	**2**
	Total for question 12		**5**

Question Number	Answer	Additional Guidance	Mark
	(a) Two point charges of 3.1×10^{-9} C and -2.4×10^{-8} C are placed a distance of 0.043 m apart in a vacuum. Calculate the magnitude of the force between the charges.		
13(a)	Use of $F = \frac{kQ_1Q_2}{r^2}$ (1) $F = 3.6 \times 10^{-4}$ N (1)	Example of calculation $F = 8.99 \times 10^9$ N m^2 C^{-2} $\times$ 3.1×10^{-9} C $\times$ 2.4×10^{-8} C $\div$ (0.043 m)^2 $F = 3.6 \times 10^{-4}$ N	**2**
	The diagram represents the electric field around two point charges of equal magnitude. A is a positive charge and B is a negative charge  **State the meaning of electric field strength.**		
13(b)(i)	Electric field strength is the force per unit (positive) charge (1)		**1**
	Deduce the direction of the electric field at X. You should consider the electric field at X due to A and due to B separately.		
13(b)(ii)	At X, a positive charge experiences a force/field due to A in the direction AX **Or** at X the horizontal component of force/field is to the right and the vertical component is upwards (1) At X, a positive charge experiences a force/field due to B and in the direction XB **Or** at X the horizontal component of force/field is to the right and the vertical component is downwards (1) Use of vector diagram **Or** statement that the components in the direction perpendicular to AB are equal and opposite **Or** resultant vertical component is zero (1)		**4**

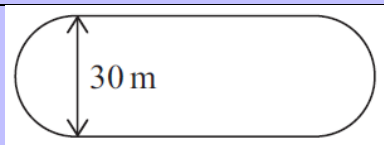
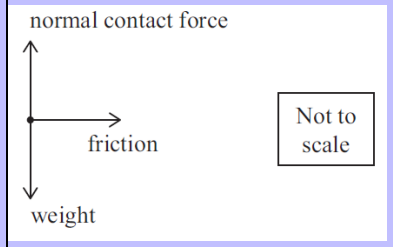
	∴ the field is in the direction AB (1)		
	Total for question 13		**7**

Question Number	Answer	Additional Guidance	Mark
	A lambda (Λ) particle is a baryon. **(a) State the structure of a baryon.**		
14(a)	3 quarks (1)		**1**
	(b) A neutral Λ particle can decay into a proton and a pion. **(i) Write this decay as a particle equation.** $\Lambda_0 \rightarrow$		
14(b)(i)	$\Lambda^0 \rightarrow p^+ + \pi^-$ (1)		**1**
	Explain how the laws of conservation of momentum and mass-energy apply to this decay process. **Assume the Λ particle is stationary.**		
14(b)(ii)	Initial momentum of Λ is zero (1) proton moves off in opposite direction to pion (1) momentum of particles is equal and opposite (1) mass-energy of Λ = mass and E_k of p and π **Or** links decrease in total mass to increase in total kinetic energy (1)		**4**

	Scientists studying antimatter recently observed the creation of an antihelium nucleus, which consists of two antiprotons and two antineutrons. **The diagram represents the path of a proton through a magnetic field starting at point A.**  **An antihelium nucleus also starts at point A and initially travels with the same velocity as the proton.** **Explain the path of the antihelium nucleus.** **You should add to the diagram the path of the antihelium nucleus.**		
14(c)	**Diagram** Path curves in opposite sense **and** line must start at A, upwards (1) With a greater radius of path (1) **Explanation** Antihelium has opposite charge to proton **Or** reference to proton as +ve **and** antihelium as negative (1) Reference to $r = p/BQ$ with $p = mv$ to justify larger radius of curvature (1)		**4**
	Total for question 14		**10**

Question Number	Answer	Additional Guidance	Mark
	Muons are produced in the Earth's upper atmosphere at a speed of 0.994 c. The number of muons reaching the Earth's surface and the number reaching a position 1600 m higher up was measured. 74% of the muons detected at 1600 m reached the Earth's surface without decaying. **Explain whether these observations are consistent with relativistic effects. Your answer should include a calculation.** **average lifetime of muons at rest = 2.2×10^{-6}s**		
15	**EITHER** • Calculate distance travelled at 0.994 *c* in the average lifetime without relativistic effects = 656 m (1) • This is (much) less than 1600 m (1) • The speed of the muon is very close to the speed of light (1) • (To the observer) The lifetime of the muons has increased due to effects of relativity (1) • The distance travelled (in the increased average lifetime) is greater (than 1600 m) so most reach the ground. (1) **OR** • Calculate the time to travel 1600 m at 0.994c = 5.4×10^{-6} s (1) • This is larger than the lifetime (1) • Speed is very close to the speed of light (1) • Time of flight, as seen by the muon, is decreased due to relativistic effects **Or** The apparent lifetime of the muons has increased due to effects of relativity (1) • Time of flight, as seen by muon, is less than lifetime so most reach ground (1)		5

	OR • Calculate speed to travel 1600 m in 2.2×10^{-6} s = 7.3×10^{8} ms^{-1} (1) • This is greater than the speed of light (1) • This is not possible (1) • (To the observer) Lifetime is longer due to relativistic effects (1) • The distance travelled in the increased average lifetime is greater (than 1600 m) so most reach the ground. (1)		
	Total for question 15		**5**

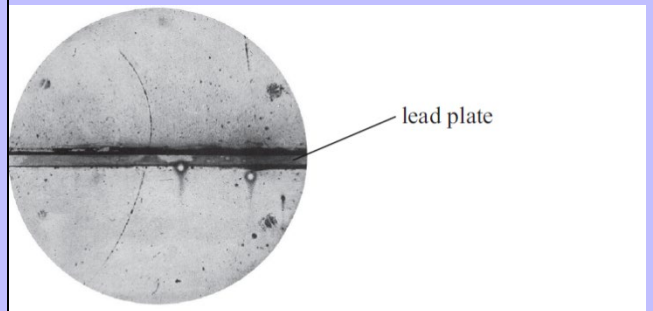
Question Number	Answer	Additional Guidance	Mark
	A go-kart is a small racing car. A go-kart track is being designed. **The track has semicircular ends with straight track in between, as shown.**  **The track must allow the go-kart to travel around the bends at a maximum safe speed of 35.0 km per hour (9.72 m s^{-1}).** **(a) The first design has a horizontal track.** **As the go-kart goes round the semicircular end of the track, centripetal force is provided by friction between the track and the tyres. This is shown in the free body force diagram below.**  **Determine whether the go-kart travels around the semicircular ends without exceeding the maximum frictional force.** **maximum frictional force = 1180 N** **mass of go-kart and driver = 185 kg**		
16(a)	• Use of $F = mv^2/r$ (1) • centripetal force = 1170 (N), with comparison and conclusion that it is safe **Or** v = 9.78 (m s^{-1}) with comparison and conclusion that it is safe **Or** d = 29.6 (m) with comparison and conclusion that it is safe (1)	Example of calculation F = 185 kg × (9.72 m s^{-1})^2/ 15 m F = 1165 N	**2**

	A second design uses a track that is banked at the semicircular ends. The track is banked at an angle θ to the horizontal. **At a speed *v*, the go-kart follows the track without any frictional force perpendicular to its motion. Show that** $\tan\theta = \frac{2v^2}{gd}$ **where *d* is the diameter of the semicircular end.**		
16(b) (i)	• State $R \sin\theta = mv^2/r$ (1) • State $R \cos\theta = mg$ (1) • Divide $R \sin\theta$ by $R \cos\theta$ and use $d/2$ (1) **OR** • Vector diagram showing normal contact force, weight and resultant centripetal force (1) • Use of trigonometry to show $\tan\theta = mv^2/r \,/\, mg$ (1) • Use of $d/2$ and algebra to show $\tan\theta = 2v^2/gd$ (1)		**3**
	(ii) Calculate the angle θ for a go-kart travelling at the maximum safe speed.		
16(b)(ii)	• Use of $\tan\theta = 2v^2 \,/\, gd$ (1) • Angle = 33° (1)	<u>Example of calculation</u> $\tan\theta = 2 \times (9.72\ \text{m s}^{-1})^2 / (9.81\ \text{N kg}^{-1} \times 30\ \text{m}) = 0.642$ $\theta = 32.7°$	**2**
	(c) A banked track will cost more to build. Suggest whether there are any significant advantages that would justify the cost.		
16(c)	Max 2 points • The track occupies a smaller space (1) • Higher speeds are possible (1) • There is less wear on the tyres/track due to less friction (1)		**2**

	Total for Question 16		**9**

Question Number	Answer	Additional Guidance	Mark
	Experiments, supervised by Rutherford one hundred years ago, involved firing alpha particles at thin gold foil. **(a) The observations from these experiments are summarised in the table.** **Complete the table with the corresponding conclusions from these observations.** **Observation** / **Conclusion** The vast majority of alpha particles go straight through without any deflection. / *(blank)* A tiny proportion of the alpha particles is deflected through angles greater than 90°. / *(blank)*		
17(a)	Conclusion for first observation: The atom is mainly empty space (1) Conclusion for second observation: There is a concentration of charge (to cause a deflection) (1) There is a concentration of mass (so that deflection > 90° possible) (1)		**3**
	(b) A gold nucleus has the symbol 197/79 Au. **(i) Determine the number of neutrons in a gold nucleus**		
17(b)(i)	$197 - 79 = 118$ (neutrons) (1)		**1**

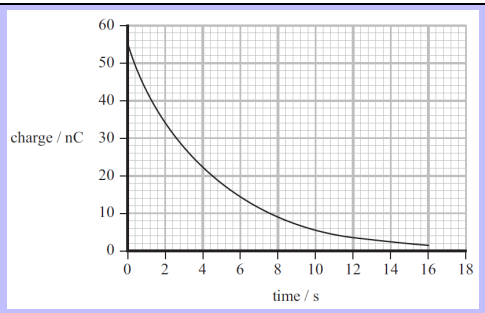
	(ii) At one moment during the experiment, an alpha particle was at a distance of 5.0×10^{-14} m from the gold nucleus. Calculate the electric potential due to the gold nucleus at this distance.		
17(b)(ii)	Use of $V = \frac{Q}{4\pi\varepsilon_0 r}$ (1) … with correct charge on nucleus (1) $V = 2.3 \times 10^6$ V (1)	Example of calculation: $Q = 79 \times 1.6 \times 10^{-19}$ C $= 1.264 \times 10^{-17}$ C $V = \frac{1.264 \times 10^{-17}\text{C}}{4 \times \pi \times 8{,}85 \times 10^{-12}\text{F m}^{-1} \times 5 \times 10^{-14}\text{ m}}$ $V = 2.27 \times 10^6$ V	**3**
	Total for question 17		**7**

Question number	Answer	Additional Guidance	Mark
	In 1932, Carl Anderson published this photograph of a track in a cloud chamber, as shown below. The cloud chamber contained a lead plate. There was a magnetic field perpendicular to the plane of the track.  (Source: © Anderson, Carl D. (1933). 'The Positive Electron'. *Physical Review* 43 (6): 491–494. DOI: 10.113/POhysREv.43.491) **The photograph shows the track of a positron from cosmic rays and is the first photographic record of an antiparticle.** **(a) State the properties of a positron that show it is the antiparticle to the electron.**		
18(a)	Mass equal (to mass of electron) (1) Charge equal and opposite (to charge of electron) (1) Lepton number (equal and) opposite (to lepton number of electron) (1)		**3**
	(b) The cloud chamber contained a lead plate. There was a magnetic field perpendicular to the plane of the track. **Deduce the direction of the magnetic field.**		
18(b)	Curvature more in top half of picture (1) Particle has less momentum after passing through lead plate (because energy lost), so moving from lower half to top half (1)		

	Applying FLHR, field into page (dependent on MP1 and MP2) (1)		**3**
	(c) In the upper part of the photograph the positron had an energy of 23 MeV. **(i) Show that the positron must have been travelling at a relativistic speed. Assume that all of its energy is kinetic energy.**		
18(c)(i)	Use of conversion factor 1.6×10^{-19} J/eV (1) Use of $E_k = \frac{1}{2} mv^2$ (1) Calculated speed = 2.8×10^9 m s^{-1}, which is greater than the speed of light (so it must be relativistic) (1)	<u>Example of calculation</u> $E_k = 23 \times 10^6$ eV $\times 1.6 \times 10^{-19}$ J/eV = 3.7×10^{-12} J 3.7×10^{-12} J = $0.5 \times 9.11 \times 10^{-31}$ kg $\times v^2$ $v = 2.8 \times 10^9$ m s^{-1}	**3**
	(ii) For relativistic particles such as this positron, momentum obeys the relationship *E* = *pc*. **where *E* = particle energy, *p* = particle momentum and c = speed of light.** **Determine the magnetic flux density of the magnetic field.** **radius of curvature of path = 3.7 cm**		
18(c)(ii)	Use of $E = pc$ (ecf for E from (c)(i)) (1) Use of $r = p/Bq$ (1) $B = 2.1$ T (1) <u>Example of calculation</u> 3.7×10^{-12} J = $p \times 3.00 \times 10^8$ m s^{-1} $p = 1.2 \times 10^{-20}$ N s 0.037 m = 1.2×10^{-20} N s / $B \times 1.6 \times 10^{-19}$ C		**3**

	$B = 2.1$ T		

	(d) A positron travelling at a non-relativistic speed of 1.5 × 107 m s^{-1} collides with an electron travelling at the same speed in the opposite direction. The positron and electron annihilate one another resulting in the production of a photon of gamma radiation. **Deduce whether the frequency of the gamma radiation produced exceeds 1.0×10^{20} Hz.**		
18(d)	Use of $E_k = ½\ mv^2$ (1) Use of $\Delta E = c^2 \Delta m$ (1) Use of $E = hf$ (1) $f = 2.4 \times 10^{20}$ Hz > 1.0×10^{20} Hz ∴ it does exceed it (1)	<u>Example of calculation</u> $E_k = 2 \times 0.5 \times 9.11 \times 10^{-31}$ kg × $(1.5 \times 10^7$ m $s^{-1})^2$ $= 2.0 \times 10^{-16}$ J $\Delta E = (3.00 \times 10^8$ m $s^{-1})^2 \times 2 \times 9.11 \times 10^{-31}$ kg $= 1.6 \times 10^{-13}$ J Total energy = 1.6×10^{-13} J + 2.0×10^{-16} J = 1.6×10^{-13} J Energy for gamma photon = 1.6×10^{-12} J 1.6×10^{-12} J = 6.63×10^{-34} J s × f $f = 2.4 \times 10^{20}$ Hz	**4**
	Total for question 18		**16**

Question Number	Answer	Additional Guidance	Mark
	A digital coulombmeter measures electric charge, as shown in the photograph below.  **The charge the coulombmeter is measuring is stored on a capacitor. A voltmeter inside the coulombmeter measures the potential difference across the capacitor. This value is converted so that the display shows the charge in nanocoulombs.** **(a) State why the voltmeter must have a very high resistance.**		
19(a)	So there would not be a current through the voltmeter **Or** So the capacitor doesn't discharge (1)		**1**
	(b) A coulombmeter is charged. A resistor with resistance 4.6 MΩ is placed across the terminals and the capacitor discharges through the resistor. The charge shown on the display is recorded and a graph of charge against time is produced.  **(i) Show that, using data from the graph, the capacitance of the capacitor in the coulombmeter is about 9.7×10^{-7} F.**		
19(b)(i)	**Either** Determine time for charge to fall to 1/e (37%) (1)	Example of calculation	

	Use of time for charge to fall $t = RC$, (1) $C = 9.78 \times 10^{-7}$ (F) (1) **Or** Take two sets of coordinates from the graph (1) Use of $Q = Q_0 e^{-t/RC}$ (1) $C = 9.66 \times 10^{-7}$ (F) (1) **Or** Determine time constant, from intercept of tangent at start with x axis Use of $t = RC$, $C = 9.66 \times 10^{-7}$ (F)	55 nC/e = 20.2 nC time at which Q is 20.2 nC = 4.6 s 4.5 s = 4.6×10^6 Ω × C $C = 9.78 \times 10^{-7}$ F	**3**
	(ii) Calculate the energy initially stored by the capacitor.		
19(b)(ii)	Use of $W = ½ Q^2/C$ (1) $W = 1.6 \times 10^{-9}$ J [ecf from (i)] (1) Example of calculation $W = ½ (5.5 \times 10^{-8}\ C)^2 / 9.66 \times 10^{-7}$ F $= 1.56 \times 10^{-9}$ J		**2**
	The notes with the coulombmeter state: ***"The coulombmeter has a much higher capacitance than the charged objects it is being used with, so effectively all of the charge is transferred to the meter."*** **Explain why the charge will be transferred to the capacitor with a much higher capacitance.**		
19(c)	(charge will flow from higher to lower V,) so p.d. will be equal across both (1) $Q = CV$, so, for same V, if C greater, Q will be greater (dependent on MP1) (1)		**2**

	The data for the graph was obtained by using a video camera to record the coulombmeter display and replaying this frame by frame. **State an advantage of using this method.**		
19d)	To obtain sufficient data points **Or** to be able to measure charge and time simultaneously **Or** can take more readings in given time (1)		**1**
	Total for question 19		**9**

20	The following passage is taken from an article about the history of particle physics. Mystery Particle By 1932, scientists knew of the existence of the subatomic particles: the electron, the proton and the neutron. These were believed to be the fundamental particles. In 1936, scientists were using tracks of cosmic rays to identify a predicted particle known as a meson. Instead, another particle was discovered, the muon. This was so surprising that Nobel Prize winning physicist Isidor Rabi said "Who ordered that?" Describe how the underlined particles fit into the standard model.		

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>*20</td><td>
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>IC points</th><th>IC mark</th><th>Max linkage mark</th><th>Max final mark</th></tr>
<tr><td>6</td><td>4</td><td>2</td><td>6</td></tr>
<tr><td>5</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>4</td></tr>
<tr><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
Indicative content
IC1 Neutrons and Protons are baryons
IC2 Baryons/Neutrons/Protons made of 3 quarks
IC3 Mesons made of a quark and an antiquark
IC4 Electrons / muons are leptons
IC5 Leptons/quarks / electrons / muons fundamental
IC6 p/n/mesons not fundamental
</td><td>6</td></tr>
<tr><td></td><td>Total for question 20</td><td>6</td></tr>
</table>