JABstem

Past Papers

Nat 5

Physics

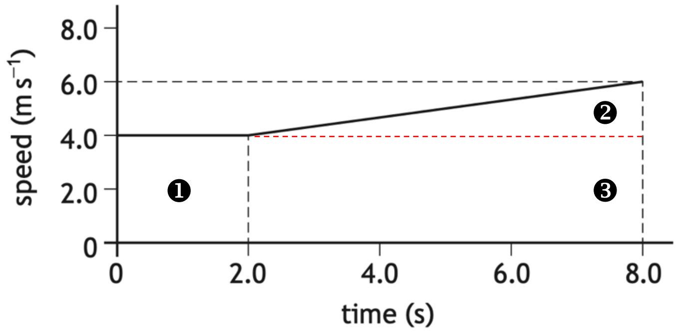
2023

Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	/100	%	
A	65+	65%	34.7%
B	52+	52%	19.8%
C	40+	40%	16.4%
D	27+	27%	15.5%
No award	<27	<27%	13.6%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	14.5 /25	38.8 /75	No Assignment in 2023

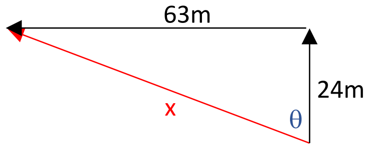
2023 Nat5 Physics Marking Scheme

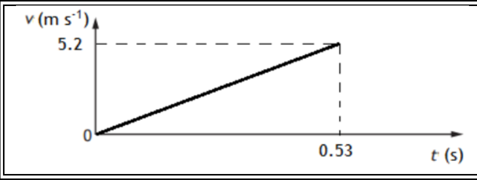
<table>
<tr><th>Question</th><th>Answer</th><th>% Correct</th><th>Physics Covered</th></tr>
<tr><td>1</td><td>D</td><td>82</td><td>
<table>
<tr><td>X</td><td>Y</td><td>Z</td></tr>
<tr><td>Vectors</td><td>force</td><td>acceleration</td></tr>
<tr><td>Vectors have both magnitude and direction while scalars only have magnitude</td><td>Force is a vector quantity with magnitude and direction.</td><td>Acceleratiton is a vector quantity with magnitude and direction.</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>D</td><td>44</td><td>
☒A $t_1 + t_2$ does not measure the time taken for the card to pass through light gate Q
☒B $t_1 + t_2$ does not measure the time taken for the card to pass through light gate Q
☒C this would measure the instantaneous speed through light gate P not light gate Q
☑D this measures the instantaneous speed through light gate Q
☒E this does not measure the instanteous speed at any pointy in the experiment
</td></tr>
<tr><td>3</td><td>C</td><td>62</td><td>


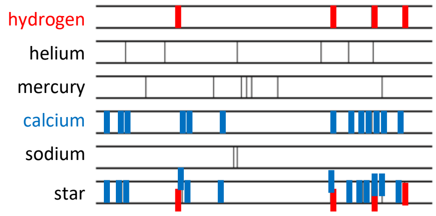
<table>
<tr><td>Area ❶</td><td>Area ❷</td><td>Area ❸</td></tr>
<tr><td>Distance = area under graph</td><td>Distance = area under graph</td><td>Distance = area under graph</td></tr>
<tr><td>= 2.0 x 4.0</td><td>= $\frac{1}{2}$ x 6.0 x 2.0</td><td>= 6.0 x 4.0</td></tr>
<tr><td>= 8m</td><td>= 6m</td><td>= 24m</td></tr>
<tr><td colspan="3">Total Distance = 8 + 6= 24m = 38m</td></tr>
</table>
</td></tr>
<tr><td>4</td><td>D</td><td>28</td><td>
E_w = ?   F = 6.0N   d = 3.0m
E_w = F d
E_w = 6.0 x 3.0
E_w = 18 J
</td></tr>
<tr><td>5</td><td>B</td><td>40</td><td>
<table>
<tr><td>Kinetic energy at 2.0 m s^{-1}</td><td>Kinetic energy at 6.0 m s^{-1}</td></tr>
<tr><td>
E_k = ?   m = 4.0 kg   v = 2.0 m s^{-1}
$E_k = \frac{1}{2} \times m \times v^2$
$E_k = \frac{1}{2} \times 4.0 \times (2.0)^2$
$E_k = \frac{1}{2} \times 4.0 \times 4.0$
E_k = 8.0 J
</td><td>
E_k = ?   m = 4.0 kg   v = 6.0 m s^{-1}
$E_k = \frac{1}{2} \times m \times v^2$
$E_k = \frac{1}{2} \times 4.0 \times (6.0)^2$
$E_k = \frac{1}{2} \times 4.0 \times 36$
E_k = 72.0 J
</td></tr>
</table>
Increase in kinetic energy = 72.0 J – 8.0 J = 64 J
</td></tr>
<tr><td>6</td><td>D</td><td>58</td><td>
T = ?   α = 0.290   d = 1 AU
<table>
<tr><td>T^2 =</td><td>280^2</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>7</td><td>A</td><td>67</td><td>
☒A Asteroid – object orbiting a star which is smaller than a dwarf planet
☒B Dwarf Planet – object which orbits a star but not large enough to be classed as a small planet
☑C Exoplanet – planet orbiting around a star outside our solar system
☒D Planet – large ball of matter. Orbiting a star which does not emit light
☒E Star – large ball of matter undergoing nuclear fusion emitting light and EM radiation
</td></tr>
</table>

8	D	48	Unwards force = 2200N Downwards force = mg = 350kg x 3.7 N kg^{-1} = 1295 N Unbalanced force = 2200N – 1295N = 905N upwards As space vehicle is decending when rockets fire then the vehicle will still decend to the surface but there is a decrease in speed as there is a unbalanced force upwards.
9	E	79	☒A A negative particle P will deflect away from a negatively charged plate R ☒B If particle P had no charge it would pass through undeflected through electric field ☒C If particle P had no charge it would pass through undeflected through electric field ☒D A positive particle P will deflect away from a positively charged plate R ☑E A positive particle P will bend towards a negatively charged plate R
10	C	81	☒A Negative charges (electrons) move in both a.c. and d.c. current ☒B In a.c. current, direction of current reverses constantly back and forth ☑C In a.c. current, charges (electrons) reverse intervals at regular interval ☒D Only negative charges (electons) move in a current in both a.c. and d.c. current ☒E The quantity of current rises and falls during a.c. current
11	D	35	Voltage across resistor R = 5.0V – 2.2V = 2.8V Current in Resistor R = 10.0 mA = 0.0100 A $R = \frac{V}{I} = \frac{2.8}{0.0100} = 280\ \Omega$
12	A	58	V_s = 24 V V_2 = ? R_1 = 2.4 kΩ R_2 = 1.2 kΩ $V_2 = \frac{R_2}{R_1 + R_2} \times V_s$ $V_2 = \frac{1.2}{2.4 + 1.2} \times 24$ $V_2 = 8\ V$
13	C	44	☒A Variable resistor is at bottom of circuit so motor will switch on when light is high. ☒B circuit contains thermistor which would make the circuit dependent on temperature ☑C Variable resistor is at top of circuit and circuit contains LDR to switch on motor on low light ☒D circuit contains thermistor which would make the circuit dependent on temperature not light ☒E circuit contains thermistor which would make the circuit dependent on temperature not light
14	E	70	P = 250 W E = ? t = 2 hours = 2x60x60 s $P = \frac{E}{t} \therefore 250 = \frac{E}{2x60x60} \therefore E = 250 \times 2x60x60 = 1860000\ J$
15	C	64	From graph: When Power P = 1 W then Resistance R = 4 Ω $P = \frac{V^2}{R} \therefore 1 = \frac{V^2}{4} \therefore V^2 = 4$ $\therefore V = 2\ V$
16	C	64	Statement I - **Correct**: The mass of the copper block gives the mass in the equation $E_h = cm\Delta T$ Statement II - **Correct**: The initial and final temperatures are needed to to calculate ΔT for the equation $E_h = cm\Delta T$ Statement III - Incorrect: The power supply does not give the energy supplied. Joulemeter provides E_h for the equation $E_h = cm\Delta T$
17	B	57	E = ? m = 3.5 kg $l = 3.34x10^5\ J\ kg^{-1}$ $E = m \times l$ $E = 3.5 \times 3.34x10^5$ $E = 1.2x10^{6.}$ J

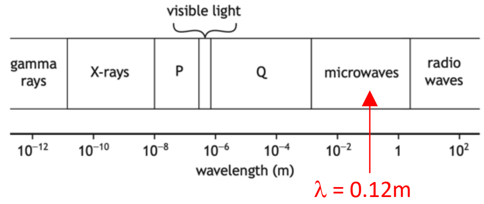
18	B	65	$P = 2.0\times10^8$ Pa $F = 5.0$ kN $= 5000$N A = ? $P = \frac{F}{A}$ $2\times10^8 = \frac{5000}{A}$ $A = 2.5\times10^{-5}\ m^2$
19	A	56	☑A Pressure & temperature are directly proportional in *pressure-temperature Law calculations* ☒B Pressure & temperature are directly proportional in *pressure-temperature Law calculations* ☒C The volume is constant in the bhoy ☒D Temperatures used in *pressure-temperature Law calculations* are measured in Kelvin ☒E Temperatures used in *pressure-temperature Law calculations* are measured in Kelvin
20	C	48	$p_1 = 5.0\times10^5$ Pa $V_1 = 2.2\ m^3$ $T_1 = 27^oC = 320$ K $p_2 = 5.5\times10^5$ Pa $V_2 = ?$ $T_2 = 54^oC = 370$ K $\frac{p_1 \quad V_1}{T_1} = \text{constant} = \frac{5.0\times10^5 \quad x \quad 2.2}{320} = 3437.5$ $\frac{p_2 \quad V_2}{T_2} = \text{constant} = \frac{5.5\times10^5 \quad x \quad V_2}{370} = 3437.5$ $V_2 = \frac{3437.5 \times 370}{5.5\times10^5}$ $V_2 = 2.3\ m^3$
21	B	58	**Amplitude:** Amplitude $= \frac{0.4}{2} = 0.2$m **Frequency:** Wavelength = $^{12m}/_2$ = 6m $f = \frac{v}{\lambda} = \frac{3.0}{6} = 0.5$Hz
22	E	69	☒A wavelength should be same before and after barrier. ☒B ends of waves should curve as waves diffract and be longer than gap in barrier. ☒C boths sides of diffracted waves should be curved after the barrier ☒D this answer is clearly nonsense ☑E wavelength the same after barrier, ends of wave curve as wave diffracts in shadow area.
23	A	41	☑A Ray P has bent away from the normal as it has gone from a more dense medium to less dense ☒B Ray Q has not changed direction and has continued in a straight line from the glass ☒C Ray R is on wrong side of the normal ☒D Ray S is on wrong side of the normal ☒E Ray T is on wrong side of the normal
24	E	65	2.4×10^4 Bq $\therefore$ 1 s = 2.4×10^4 decays $\therefore$ 15x60 s = 2.4×10^4 decays x15x60 = 2.2×10^7
25	B	62	**Statement I - Incorrect:** Nuclear *fission* is when a large nucleus splits into smaller nuclei **Statement II - Correct:** At the very hot temperatures required for fusion to take place, containment of plasma is an issue **Statement III - Incorrect:** Nuclear fusion takes place only at *high* temperatures

<table>
<tr><th>Question</th><th>Answer</th><th>Physics Covered</th></tr>
<tr><td>1a(i)</td><td>67 m</td><td>Horizontal displacement = 74m – 11m = 63m (WEST or 270)
Vertical displacement = 38m – 14m = 24m (North or 000)


$x = \sqrt{(24)^2 + (63)^2}$
$x = \sqrt{576 + 3969}$
$x = \sqrt{4545}$
$x = 67$ m</td></tr>
<tr><td>1a(ii)</td><td>291</td><td>$\tan\theta = \frac{opp}{adj} = \frac{63}{24} = 2.625 \quad \therefore \ \theta = 69^o$
Bearing = $360^o - 69^o$ = 291</td></tr>
<tr><td>1b(i)</td><td>2.2 m s^{-1} at bearing 291</td><td>S = 67 m $\bar{\upsilon}$ = ?   t = 31 s
$s = \bar{\upsilon} \ t$ (1 mark)
$67 = \bar{\upsilon} \times 31$ (1 mark)
$\bar{\upsilon} = 2.2$ m s^{-1} (1 mark)</td></tr>
<tr><td>1b(ii)</td><td><u>1 mark</u>
distance is greater than displacement
<u>1 mark</u>
same time taken</td><td>The distance travelled is greater than the displacement as in both the vertical and horizontal direections.<table><tr><th>Direction</th><th>Displacement</th><th>Distance</th></tr><tr><td>Horizontal (West – East)</td><td>74m – 11m = 63m</td><td>74m + 11m = 85m</td></tr><tr><td>Vertical (North – South)</td><td>38m – 14m = 24m</td><td>38m + 14m = 52m</td></tr></table>Because the total distance and the displacement take place over the same time period, the average velocity is less because the displacement is less before being divided by the time taken.</td></tr>
<tr><td>1c(i)</td><td>Working showing 0.18J</td><td>E_p = ?   m = 0.0025 kg   g = 9.6 N kg^{-1} h = 7.5 m
$E_p = m \ g \ h$ (1 mark)
$E_p = 0.0025 \times 9.8 \times 7.5$ (1 mark)
$E_p = 0.18$ J</td></tr>
<tr><td>1c(ii)</td><td>12 m s^{-1}</td><td>E_k = 0.18 J   m = 0.0025 kg   v = ?
$E_k = \frac{1}{2} m v^2$ (1 mark)
$0.18 = \frac{1}{2} \times 0.0025 \times v^2$ (1 mark)
$v^2 = \sqrt{144}$
$v = 12$ m s^{-1} (1 mark)</td></tr>
<tr><td>1c(iii)</td><td>One answer from:</td><td><u>Energy</u> lost (as heat) due to { friction / air resistance</td></tr>
<tr><td>2a</td><td></td><td>A suitable curved path where the ball does not increase in height.
• The stone will have fall vertically faster the further it falls due to gravity
• The horizontal velocity will remain the same</td></tr>
<tr><td>2b(i)</td><td>5.2 m s^{-1}</td><td>a = 9.8 m s^{-2} v = ?   u = 0 m s^{-1} t = 0.53 s
$a = \frac{v - u}{t}$ (1 mark)
$9.8 = \frac{v - 0}{0.53}$ (1 mark)
$9.8 \times 0.53 = v - 0$
5.2 m s^{-1} = v (1 mark)</td></tr>
<tr><td>2b(ii)</td><td>Graph showing:</td><td>
<table><tr><th>1st Mark</th><th>2nd Mark</th></tr><tr><td>Straight line
Positive gradient
Starting at origin</td><td>Graph ends at (0.53, 5.2)</td></tr></table></td></tr>
</table>

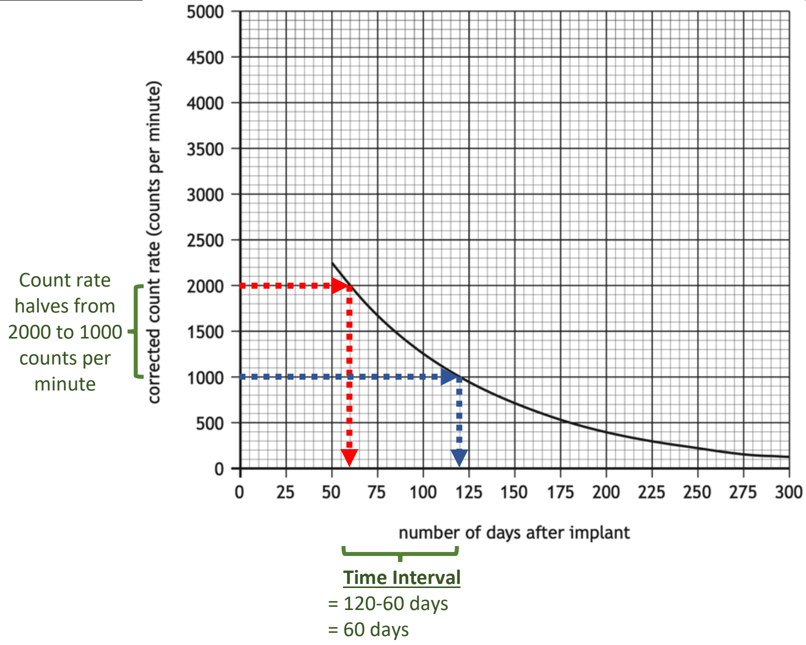
2b(iii)	1.4 m	Height dropped from = area under graph (1 mark) = $\frac{1}{2}$ x 0.53 x 5.2 (1 mark) = 1.4 m (1 mark)
2c(i)	0.43 m s^{-2}	F_{un} = 54 N – 22 N = 32 N m = 74 kg a = ? F = m a 32 = 74 x a a = 0.43 m s^{-2}
2c(ii)	Reduces friction or air resistance	The cyclist take sthe full air resistamnce while the rider behind benefits from less air resistance as a result.
3a	Answer to include:	1 mark: Astra 1KR 1 mark: it is a geostationary satellite or it has an orbital period of 24 hours or it is at an orbital altitude of 36 000 km
3b	27N	W = ? m = 3.5kg g = 7.7 N kg^{-1} W = m x g (1 mark) W = 3.5 x 7.7 (1 mark) W = 27 N (1 mark)
3c	Answer is Greater then 101 minutes and Less than 676 minutes	Satellite / Orbital Altitude (km) / Orbital Period UKube-1 / 825 / 101 minutes Satellite / 1200 / Longer than 101minutes & shorter than 676 minutes Kosmos2460 / 19100 / 676 minutes
4	Open ended question:	**1 mark:** Candidate has demonstrated a limited understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood at least a little of the physics within the problem. **2 marks:** Candidate has demonstrated a reasonable understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem. **3 marks:** Candidate has demonstrated a good understanding of the physics involved. They show a good comprehension of the physics of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks.
5a	One answer from:	not affected by weather / no (distortion from) atmosphere / no light pollution / can use telescope during the day
5b	Hydrogen Calcium (both required for 1 mark)	 All hydrogen lines in line spectra from star Some helium lines missing from star Some mercury lines missing from star All calcium lines in line spectra from star Some sodium lines missing from star
5c	working showing 3.2x10^{18} m	d = v x t (1 mark) d = 3.0x10^{8} x 343 x 365.25 x 24 x 60 x 60 (1 mark) d = 3.2x10^{18} m
6a	0.20 A	Total Resistance when Switch S_1 is closed = 36Ω + 24Ω = 60Ω (1 mark) V = 12 V I = ? R = 60 Ω V = I R (1 mark) 12 = I x 60 (1 mark) I = 0.20 A (1 mark)
6b(i)	3.2 Ω	**Combine 2 parallel resistors** $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ (1 mark) $\frac{1}{R_T} = \frac{1}{36} + \frac{1}{36}$ (1 mark) $\frac{1}{R_T} = \frac{2}{36}$ R_T = 18 Ω **Combine with series resistor** $R_T = R_1 + R_2$ R_T = 18 + 36 (1 mark) R_T = 42 Ω (1 mark)

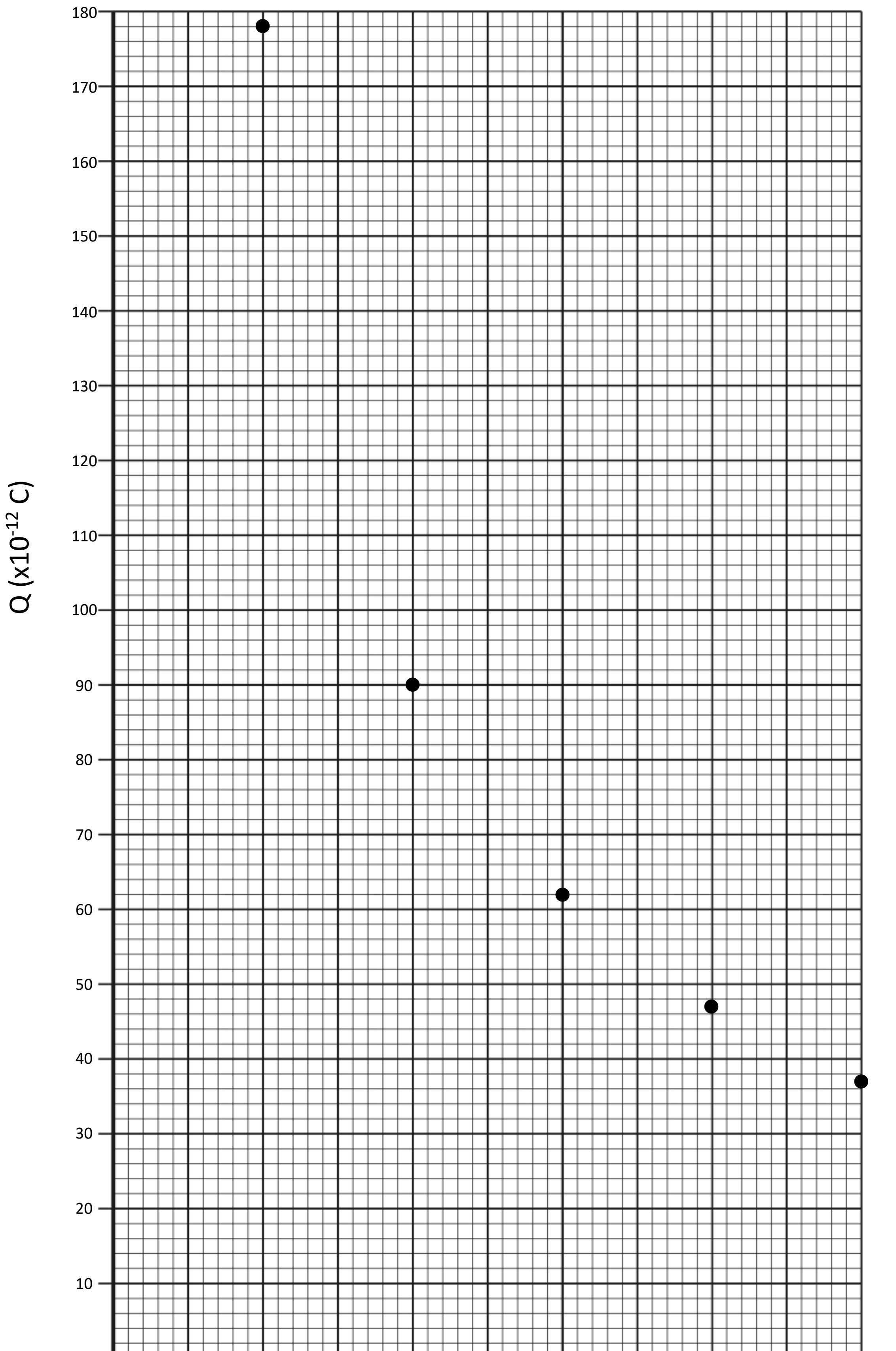
6b(ii)	Answer to include:	1 mark: (Ammeter reading will be) greater 1 mark: Total circuit resistance will be less
7a(i)	Graph showing:	<u>1 mark</u>: Suitable scales, labels and units <u>1 mark</u>: All points plotted accurately to ± half a division <u>1 mark</u>: Best fit <u>curve</u>
7a(ii)	74×10^{-12} C	
7b	Any two from: (1 mark each)	Repeat measurements and average Repeat measurements to identify outliers/rogue points Increase the range of distances Increase the number of different distances
8a(i)	2120 J	$E_h = ?$ $c = 532\ J\ kg^{-1}\ {}^{o}C^{-1}$ $m = 1.90 \times 10^{-2}$ kg $\Delta T = 235^{0}C - 25^{o}C = 210^{o}C$ $E = c \times m \times \Delta T$ (1 mark) $E = 532 \times 1.90 \times 10^{-2} \times 210$ (1 mark) $E = 2120$ J (1 mark)
8a(ii)	Heat (energy) lost to the surroundings.	Heat loss must be indentified as being lost to the surroundings
8b	Answer to include:	1 mark: different (specific) heat capacity 1 mark: different mass
9a(i)	Force per unit area or Force per m^2	Pressure is calcuated from equation $P = {}^{Force}/_{Area}$ and is defined as Force per unit area
9a(ii)	$2.5 \times 10^{-3}\ m^3$	$p_1 = 101$ kPa $V_1 = 2.3 \times 10^{-3}\ m^3$ $p_2 = 92$ kPa $V_2 = ?$ (1 mark) $p_1V_1 = p_2V_2$ (1 mark) $101 \times 2.3 \times 10^{-3} = 92 \times V_2$ $\frac{101 \times 2.3 \times 10^{-3}}{92} = V_2$ (1 mark) $2.5 \times 10^{-3}\ m^3 = V_2$
9a(iii)	The (gas) particles collide with the walls (of the crisp packet).	Pressure is caused by the particles inside a gas colliding with the walls of they container the gas in is. The faster te gas particles collide with the walls of the container the higher the pressure.
9b	21 μSv	$\dot{H} = 6.0\ \mu Sv\ h^{-1}$ $H = ?$ $t = 3.5$ hours $\dot{H} = \frac{H}{t}$ (1 mark) $6.0 = \frac{H}{3.5}$ (1 mark) $H = 21\ \mu Sv$ (1 mark)
10a	2.6 m	$d = ?$ $v = 240\ m\ s^{-1}$ $t = \frac{0.015s}{2} = 0.0075s$ (1 mark) $d = v \times t$ (1 mark) $d = 340 \times 0.0075$ (1 mark) $d = 2.6$ m (1 mark)
10b(i)	Working shown to calculate 45000Hz	$f = ?$ $N = 9$ waves $t = 2.0 \times 10^{-4}$ s $f = \frac{N}{t} = \frac{9}{2.0 \times 10^{-4}} = 45000$ Hz (1 mark) (1 mark)
10b(ii)	One answer from:	Speed of sound in air is the same The distance is the same

<table>
<tr><td>11a</td><td>P: Ultraviolet
Q: Infrared</td><td><table>
<tr><td>EM Type</td><td>Gamma</td><td>X-Ray</td><td>Ultra-violet</td><td>Visible</td><td>Infra-Red</td><td>Microwave</td><td>Radio & TV</td></tr>
<tr><td>Energy</td><td>High</td><td colspan="5">←→</td><td>Low</td></tr>
<tr><td>Frequency</td><td>High</td><td colspan="5">←→</td><td>Low</td></tr>
<tr><td>Wavelength</td><td>Low</td><td colspan="5">←→</td><td>High</td></tr>
</table></td></tr>
<tr><td>11b</td><td>Answer to include:</td><td><table>
<tr><td>1 mark : Radio Waves
1 mark : Longest Wavelength</td><td>Diffraction is greater when the wavelength is longer.
Radio waves have the longest wavelength of all types of electromagnetic radiation</td></tr>
</table></td></tr>
<tr><td>11c(i)A</td><td>Working showing calculation of wavelength</td><td>$v = 3.0 \times 10^8$ m s^{-1} $f = 2.42$GHz $= 2.42 \times 10^9$ Hz $\lambda = ?$
$v = f \times \lambda$ (1 mark)
$3.0 \times 10^8 = 2.42 \times 10^9 \times \lambda$ (1 mark)
$\lambda = 0.12$ m</td></tr>
<tr><td>11c(i)B</td><td>microwaves</td><td>
</td></tr>
<tr><td>11c(ii)A</td><td>2.3×10^{-5} J</td><td>$D = 5.0\ \mu Gy = 5.0 \times 10^{-6}$ Gy $E = ?$ $m = 4.5$ kg
$D = \frac{E}{m}$ (1 mark) $\therefore$ $5.0 \times 10^{-6} = \frac{E}{4.5}$ (1 mark) $\therefore$ $E = 5.0 \times 10^{-6} \times 4.5 = 2.3 \times 10^{-5}$ J (1 mark)</td></tr>
<tr><td>11c(ii)B</td><td>5.0×10^{-6} Sv</td><td>$H = ?$ $D = 5.0\ \mu Gy = 5.0 \times 10^{-6}$ Gy w_r (X-rays) = 1
$H = D\ W_r$ (1 mark)
$H = 5.0 \times 10^{-6} \times 1$ (1 mark)
$H = 5.0 \times 10^{-6}$ Sv (1 mark)</td></tr>
<tr><td>12</td><td>Open ended question:</td><td><table>
<tr><td>1 mark</td><td>2 marks</td><td>3 marks</td></tr>
<tr><td>Candidate has demonstrated a limited understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood at least a little of the physics within the problem.</td><td>Candidate has demonstrated a reasonable understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem.</td><td>Candidate has demonstrated a good understanding of the physics involved. They show a good comprehension of the physics of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks.</td></tr>
</table></td></tr>
<tr><td>13a</td><td>Answer to include:</td><td><table>
<tr><td>1 mark</td><td colspan="4">Source Y</td></tr>
<tr><td>1 mark</td><td colspan="4">Sheet of paper absorbs alpha radiation (reducing the count rate)</td></tr>
<tr><td>1 mark</td><td>lead absorbs gamma radiation reducing the count rate further</td><td>Some gamma radiation is able to penetrate lead</td><td>The gamma radiation is able to penetrate the aluminium</td><td>(Source) Y is the only source with a reduction in count rate due to paper</td></tr>
</table></td></tr>
<tr><td>13b(i)</td><td>One answer from:</td><td><table>
<tr><td>When an (uncharged) atom gains or loses electron(s)</td><td>When an (uncharged) atom gains electron(s)</td><td>When an (uncharged) atom loses electron(s)</td></tr>
</table></td></tr>
<tr><td>13b(ii)</td><td>Answer to include:</td><td><table>
<tr><td>1 mark</td><td colspan="3">Alpha radiation</td></tr>
<tr><td>1 mark</td><td>Alpha radiation only has a short range (in air)</td><td><u>or</u></td><td>Fewer alpha particles would reach the spark counter at increased distance</td></tr>
</table></td></tr>
<tr><td>13b(iii)</td><td>7.5×10^{-8} C</td><td>$Q = ?$ $I = 0.12\ \mu A = 0.12 \times 10^{-6}$ A $t = 1$ minute = 60s
For 96 sparks:
$Q = I \times t$ (1 mark)
$Q = 0.12 \times 10^{-6} \times 60$ (1 mark)
$Q = 7.2 \times 10^{-6}$ C

For 1 spark:
$Q = \frac{7.2 \times 10^{-6} C}{96}$ (1 mark)

$Q = 7.5 \times 10^{-8}$ C (1 mark)</td></tr>
</table>

14a(i)	background count rate	The background count rate should be subtracted from the count rate to the corrected count rate is a true measure of the activity from inside the boy.
14a(ii)	60 days	 Take any halving of the corrected count rate on the y-axis. Work out the time interval on the x-axis for this halving.
14a(iii)	180 days	$1 \rightarrow {}^1/_2 \rightarrow {}^1/_4 \rightarrow {}^1/_8$ 3 half-lives to decrease activity to $^1/_8$ of original value (1 mark) 1 half-life = 60 days ∴ 3 half-lives = 3x60 days = 180 days (1 mark)
14a(iv)	4000 counts per minute	Half-life is 60 days. ∴ 0 days is one half-life before 60 days and the count rate at 0 days should be double the count rate at 60 days. At 60 days the count rate is 2000 days ∴ at 0 days the count rate should be double at 4000 counts per minute.
14b	Any suitable answer including:	tracers sterilisation smoke detectors measuring thickness of paper


Q (x10^{-12} C)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
d (mm)