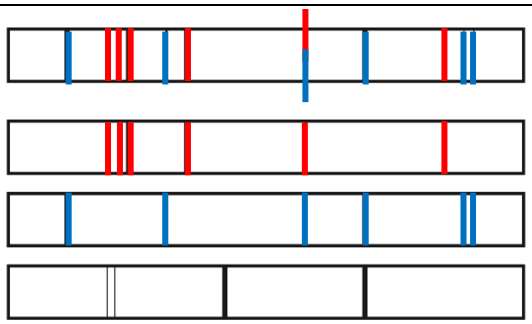
Past Papers
Nat 5
Physics
2018
Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	/125	%	
A	86+	68.8%	31.2%
B	72+	57.6%	23.3%
C	58+	46.4%	20.5%
D	44+	35.2%	14.6%
No award	<44	<35.2	10.4%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	16.4 /25	39.4 /75	17.2 /25

2018 Nat5 Physics Marking Scheme

<table>
<tr><th>Question</th><th>Answer</th><th>Physics Covered</th></tr>
<tr><td>1</td><td>E</td><td>
<table>
<tr><td>Vector Quantity</td><td>force</td><td>velocity</td><td>displacement</td><td>acceleration</td><td>weight</td></tr>
<tr><td>Scalar Quantity</td><td>mass</td><td>speed</td><td>distance</td><td>time</td><td>energy</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>D</td><td>Total distance = 50m + 120m + 50m + 120m = 340m
Displacement = 0m as start and end positions are the same.</td></tr>
<tr><td>3</td><td>E</td><td>☒A there is the force of gravity acting on the ball in the vertical direction
☒B there is no horizontal force acting on a ball thrown vertically
☒C once the ball stops moving upwards there is no upwards force acting on the ball
☒D there is no upwards force to balance the force of gravity pulling on the ball
☑E Only force of gravity is acting on the ball in the downwards direction once it stops moving up</td></tr>
<tr><td>4</td><td>C</td><td>E_w = ? F = 120 N d = 25 m
$E_w = F \times d$
$E_w = 120 \times 25$
$E_w = 3000$ J
P = ? E = 3000J t = 5.0 s
$P = \frac{E}{t} = \frac{3000}{5.0} = 600$ W</td></tr>
<tr><td>5</td><td>A</td><td>A galaxy is a collection of stars. Each star may have a solar system where a collection of planets orbiting around a star. Each planet many have natural moons orbiting those planets or artificial satellites in orbit.</td></tr>
<tr><td>6</td><td>C</td><td>
<table>
<tr><td>Satellite</td><td>Iridium-124</td><td>Satellite</td><td>Astra-5B</td></tr>
<tr><td>Orbital Height</td><td>630 km</td><td>23000 km</td><td>36000 km</td></tr>
<tr><td>Period</td><td>97 minutes</td><td>(835 minutes)</td><td>1440 minutes</td></tr>
</table>
Satellite has orbital height between Iridium-124 & Astra-5B ∴ satellite has period between Iridium-124 & Astra-5B
</td></tr>
<tr><td>7</td><td>D</td><td>Rocket travels at constant speed. There is no air resistance to slow the rocket down. so when the engines are turned off forces are balanced and the spacecraft travels an constant speed in a straight line.</td></tr>
<tr><td>8</td><td>A</td><td>☑A Mass is the same, weight is greater as gravitational field strength is greater.
☒B Mass does not change regardless of the planet's gravitational field strength
☒C For weight to be same, the gravitational field strength would need to be the same
☒D Mass does not change regardless of the planet's gravitational field strength
☒E For weight to be less, the gravitational field strength would need to be less</td></tr>
<tr><td>9</td><td>D</td><td>$d = v \times t$
$d = 3\times10^8 \times 8.6 \times 365.25 \times 24 \times 60 \times 60$
$d = 8.1\times10^{16}$ m</td></tr>
<tr><td>10</td><td>C</td><td>line spectrum from star
Element X
Element Y
Element Z
  </td></tr>
<tr><td>11</td><td>E</td><td>
<table>
<tr><th>Statement I - Correct</th><th>Statement II - Correct</th><th>Statement III - Correct</th></tr>
<tr><td>In an a.c. circuit the direction of the current does change regularly</td><td>In a d.c. circuit negative charges do flow in one direction only.</td><td>In an a.c. circuit the size of the current does varies with time.</td></tr>
</table>
</td></tr>
</table>

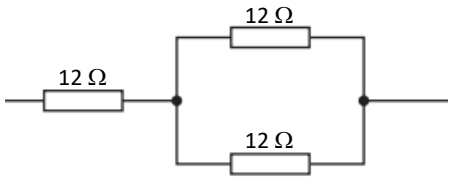
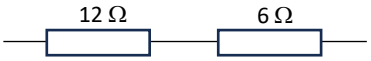
12 — D

Observation	Conclusion	Answers Ruled Out	
Particles Bends towards Q	Particle and Q cannot have same charge	☒B	☒E
Particle Bends away from R	Particle and R have same charge	☒A	☒C

13 — A

Voltage Across In Thermistor	Voltage Across Variable Resistor	LED
Decreases	**Increases**	**Switches On**
Increasing the temperature of a thermistor decreases the resistance of the thermistor. Decreasing the resistance of the thermistor will decrease the voltage over the thermistor	If the voltage over the thermistor decreases the voltage over the variable resistor will increase at same time.	The decrease in voltage over the thermistor and increase in voltage over the variable resistor leads to the transistor switching on

14 — C

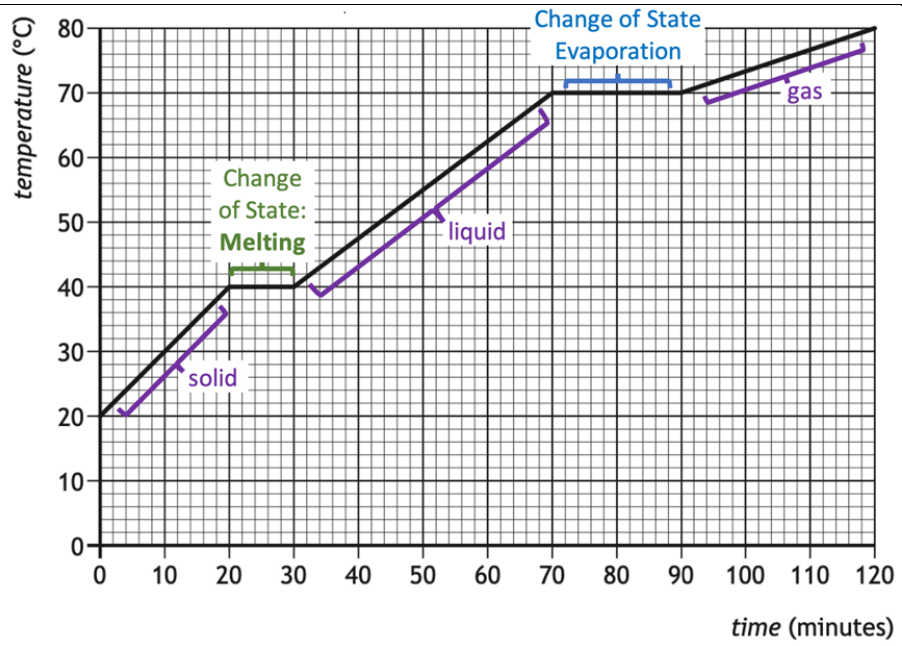
Combining Parallel Resistors:	Combining Series Resistors:
	
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{R_T} = \frac{1}{12} + \frac{1}{12}$ $\frac{1}{R_T} = \frac{2}{12}$ $R_T = 6\ \Omega$	$R_T = 12 + 6 = \mathbf{18\ \Omega}$

15 — B

P = ? V = 12V R = 4.0Ω

$$P = \frac{V^2}{R} = \frac{(12)^2}{4.0} = \frac{144}{4.0} = 36\ W$$

16 — C



17 — C

P = 1.0×10^5 Pa – 0.40×10^5 Pa = 0.6×10^5 Pa F = ? A = 2.0 m^2

$$P = \frac{F}{A}$$

$$0.6\times10^5 = \frac{F}{2.0}$$

$$F = 1.2\times10^5\ N$$

18 — B

Temperature Change in degrees Celsius = 70°C – (-20°C) = 90°C

∴ Temperature Change in Kelvin = 90K

19 — E

Temperature: Constant

$p_1 = 1.2\text{x}10^5$ Pa $V_1 = 4.0\text{x}10^{-5}$ m^3

$p_2 = ?$ $V_2 = 0.80\text{x}10^{-5}$ m^3

$p_1V_1 = p_2V_2$

$1.2\text{x}10^5 \times 4.0\text{x}10^{-5} = p_2 \times 0.80\text{x}10^{-5}$

$$\frac{1.2\text{x}10^5 \times 4.0\text{x}10^{-5}}{0.80\text{x}10^{-5}} = p_2$$

$6.0\text{x}10^5$ Pa $= p_2$

20 — B

Statement I - Incorrect	Statement II - **Correct**	Statement III - Incorrect
Refraction occurs when waves pass from one medium to another	Diffraction is greater in waves with a longer wavelength	Microwaves have a shorter wavelength than radio waves so microwaves diffract less than radio waves

21 — A

☑A Radiation R is X-rays and have a higher frequency than visible light
☒B Radiation R is X-rays as this radiation is between gamma and ultraviolet
☒C X-rays have a higher frequency than visible light
☒D Radiation R is X-rays as this radiation is between gamma and ultraviolet
☒E Radiation R is X-rays as this radiation is between gamma and ultraviolet

22 — C

E = ? $\rho = 1.02\text{x}10^3$ kg m^{-3} g = 9.8 N kg^{-1} A =3.5 m

$$E = \frac{\rho g A^2}{2} = \frac{1.02\text{x}10^3 \times 9.8 \times (3.5)^2}{2} = \frac{122451}{2} = 61226 \text{ J} = 6.1\text{x}10^4 \text{ J}$$

23 — A

$\dot{H} = 0.40$ mSv h^{-1} H = ? t = 30minutes = 0.5h

$$\dot{H} = \frac{H}{T} \qquad 0.40 = \frac{H}{0.5} \qquad H = 0.40 \times 0.5 = 0.20 \text{ mSv}$$

24 — B

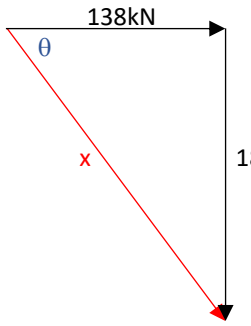
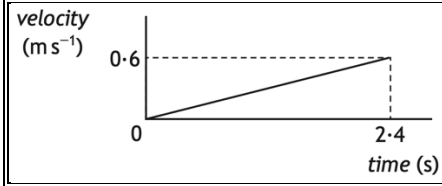
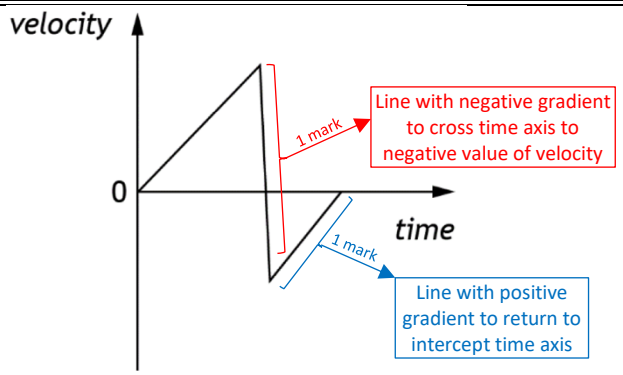
200kBq → 100kBq → 50kBq → 25kBq

3 half-lives in 12 days

$\therefore$ 1 half-life = 4 days

25 — B

X	Y	Z
Fusion Nuclear fusion reactions involve 2 smaller nuclei joining together to make a larger nucleus	**High** Fusion reactions only take place at very high temperatures	**Energy** Energy can be released when small nuclei join together in a fusion reaction

Question	Answer	Physics Covered
1a(i)A	230 kN	 $x = \sqrt{(138)^2 + (184)^2}$ $x = \sqrt{19044 + 33856}$ $x = \sqrt{52900}$ $x = 230$ kN
1a(i)B	143	$\tan\theta = \frac{\text{opp}}{\text{adj}} = \frac{184}{138} = 1.333 \quad \therefore \ \theta = 53^o$ Bearing = $90^o + 53^o = 143$
1a(ii)	3.4 m s^{-2}	F = 230000 N m = 6.8x10^4 kg a = ? F = m a (1 mark) 230000 = 6.8x10^4 x a (1 mark) a = 3.4 m s^{-2} (1 mark)
1b	Answer to include:	1 mark: mass / weight / (downward) force } is less 1 mark: pressure is force per unit area <u>or</u> pressure is weight per unit area
2a(i)	One answer from:	Time for card to { cut / pass through } light gate X
2a(ii)	0.46 m s^{-1}	$v = \frac{\text{length of card}}{\text{time for card to cut beam}} = \frac{0.045}{0.098} = 0.46$ m s^{-1} (1 mark) (1 mark)
2a(iii)	0.25 m s^{-2}	a = ? v = 0.46 m s^{-1} u = 0.32 m s^{-1} t = 0.56 s $a = \frac{v - u}{t} = \frac{0.46 - 0.32}{0.56} = 0.25$ m s^{-2} (1 mark) (1 mark) (1 mark)
2b	0.72 m	 Distance = area under graph = ½ x 2.4 x 0.6 = 0.72 m
2c	Graph showing	
3a	2400J	E_k = ? m = 75 kg v = 8.0 m s^{-1} $E_k = \frac{1}{2}$ m v^2 (1 mark) $E_k = \frac{1}{2}$ x 75 x $(8.0)^2$ (1 mark) E_k = 2400 J (1 mark)

3b(i) — 3.3 m

$E_p = 2400$ J $m = 75$ kg $g = 9.8$ N kg^{-1} $h = ?$

$E_p = m \; g \; h$ (1 mark)

$2400 = 75 \times 9.8 \times h$ (1 mark)

$h = 3.3$ m (1 mark)

3b(ii) — One answer from:

Energy lost (as heat and sound) due to { friction / air resistance }

3c(i)

A suitable curved path where the bike does not increase in height.

- The bike will have fall vertically faster the further it falls due to gravity
- The horizontal velocity will remain the same

3c(ii) — 3.9 m s^{-1}

$a = 9.8$ m s^{-2} $v = ?$ $u = 0$ m s^{-1} $t = 0.40$ s

$a = \dfrac{v - u}{t}$ (1 mark)

$9.8 = \dfrac{v - 0}{0.40}$ (1 mark)

$9.8 \times 0.40 = v - 0$

3.9 m s$^{-1} = v$ (1 mark)

4a(i) — 2.28x10^{11} m

$d = 1.5\text{x}10^{11} \times 1.52$

$d = 2.28\text{x}10^{11}$ m

4a(ii) — 760 s

$d = 2.28\text{x}10^{11}$ m $v = 3.0\text{x}10^{8}$ m s^{-1} $t = ?$

$d = v \times t$ (1 mark)

$2.28\text{x}10^{11} = 3.0\text{x}10^{8} \times t$ (1 mark)

$t = 760$ s (1 mark)

4b(i) — One answer from:

solar cells	solar panels	generator (RTG)
nuclear reactors	radioisotope thermoelectric	

4b(ii) — One answer from:

Fuel load on take-off	Pressure differential	Re-entry through an atmosphere
Manoeuvring in zero friction environment	Potential exposure to radiation	

5 — Answer to include:

1 mark	2 marks	3 marks
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.	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.	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.

6a — 3.6 V

$V_s = 4.0$ V $V_2 = ?$ $R_1 = 2.0\ \Omega$ $R_2 = 18\ \Omega$

$V_2 = \dfrac{R_2}{R_1 + R_2} \times V_s$ (1 mark)

$V_2 = \dfrac{18}{18 + 2.0} \times 4.0$ (1 mark)

$V_2 = 3.6$ V (1 mark)

6b(i) — One answer from:

To { reduce / limit } the current (in the LED)

Also accepted:

To reduce the voltage across the LED	To protect/prevent damage to the LED

6b(ii) — 72 Ω

Each branch of circuit has same voltage = 3.4V.

Voltage of 1.6 V is across each LED ∴ 3.4V - 1.6V = 1.8 V across each resistor (1 mark)

$V = 1.8$ V $I = 25$ mA $= 25\text{x}10^{-3}$ A $R = ?$

$V = I \; R$ (1 mark)

$1.8 = 25\text{x}10^{-3} \times R$ (1 mark)

$R = 72\ \Omega$ (1 mark)

6c — 2900 C

Q = ? I = 0.135 A t =. 6.0 hours. = 6.0x60x60

Q = I t (1 mark)

Q = 0.135 x 6.0x60x60 (1 mark)

Q = 2900 C (1 mark)

7 — Answer to include:

1 mark	2 marks	3 marks
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.	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.	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.

8a(i) — 5400 kJ kg^{-1} ^{o}C^{-1}

E = 21600 J c = ? m = 0.50 kg $\Delta T = 24^{0}C - 16^{o}C = 8^{o}C$

E = c x m x ΔT (1 mark)

21600 = c x 0.50 x 8 (1 mark)

c = 5400 kJ kg^{-1} ^{o}C^{-1} (1 mark)

8b(ii) — One answer from:

Heat (energy) is lost to the surroundings/to air or some of the heat (energy) is used to heat up the heater/beaker.

8b — 450 s

P = ? I = 4.0A V = 12V

P = I x V (1 mark)

P = 4.0 X 12

P = 48W

P = 48 W. E = 21600 J t = ?

$P = \frac{E}{t}$ (1 mark)

$48 = \frac{21600}{t}$ (1 mark)

t = 450 s (1 mark)

8c — Answer to include:

1 mark	Measure the mass of water evaporated
1 mark	Measure the energy supplied
1 mark	$E_h = ml$

9a(i) — One of the 3 methods shown:

2 marks for using 2 or more sets of data to work out $^{p}/_{T}$ values. ($^{T}/_{p}$ also acceptable)

$\frac{p}{T} = \frac{121x10^3}{323} = 375$	$\frac{p}{T} = \frac{124x10^3}{333} = 372$	$\frac{p}{T} = \frac{128x10^3}{343} = 373$	$\frac{p}{T} = \frac{132x10^3}{353} = 374$

1 mark for a statement of relationship: $\frac{p}{T}$ = constant

or

Alternative Method 1:	Alternative Method 2: Graphical Method
Use of $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ to verify relationship	Graph drawn on graph paper with
1 mark: all four sets of data (min 3 calculations)	1 mark: Suitable scales, labels and units
1 mark: all calculations correct	1 mark: All points plotted accurately
1 mark: Relationship stated and supported	1 mark: relationship stated

9a(ii) — Answer to include:

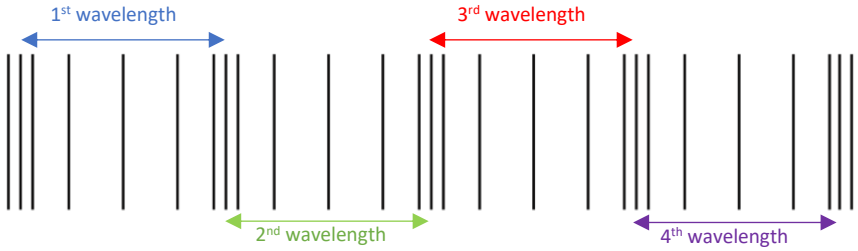
1 mark	The increase in temperature increases	the kinetic energy of the gas particles / the particles move faster
1 mark	The particles hit the container/walls more frequently	
1 mark	The particles hit the container/walls with greater force	

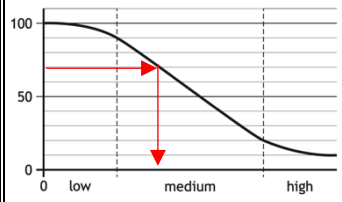
9a(iii) — 83 kPa – 89 kPa

Temperature (K)	253	273	293	313	333	353
Pressure (kPa)	-	-	101	107	116	122
Difference		(7)	(7)	6	9	6
Estimate	87	94	-	-	-	-

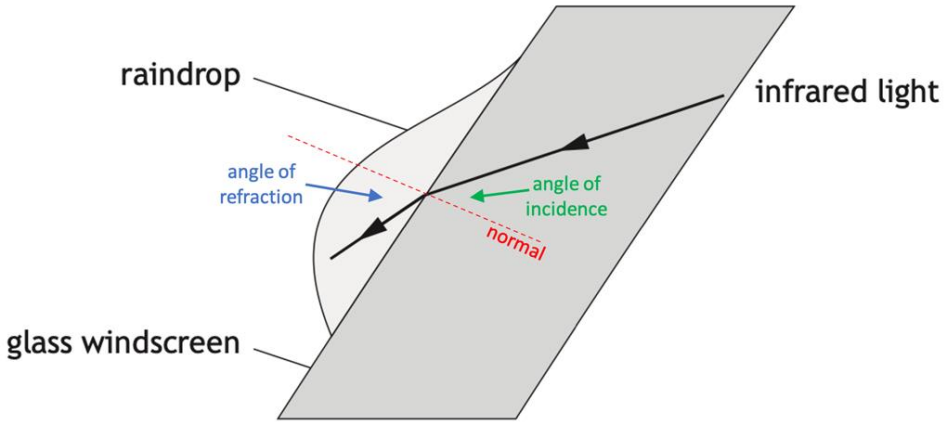
9b — Answer to include

Marks	1st mark	2nd mark
Route 1	Have more of the flask under the water	so that the gas is at the same temperature/evenly heated
	or	
Route 2	Reduce the length/diameter/volume of the connecting tube	so that the gas is at the same temperature/evenly heated

<table>
<tr><td>10a</td><td>6.3 m</td><td>D = ? $\quad$ $v = 3x10^8$ m s^{-1} $\quad$ $t = 2.1x10^{-8}$ s
d = v x t (1 mark)
d = $3.0x10^8$ x $2.1x10^{-8}$ (1 mark)
d = 6.3m (1 mark)</td></tr>
<tr><td>10b(i)</td><td>One answer from:</td><td>vibrations/oscillations are in the same direction as the energy transfer. | vibrations/oscillations are in the same direction as the wave is travelling.</td></tr>
<tr><td>10b(ii)</td><td>0.068m</td><td>No. of wavelengths shown = 4 (each triple line represents the beginning/end of a wave)
 

$\lambda = \frac{0.272m}{4} = 0.068m$</td></tr>
<tr><td>10b(iii)</td><td>5000 Hz</td><td>f = ? $\quad$ $v = 340$ m s^{-1} $\quad$ $\lambda = 0.068$ m
v = f x λ (1 mark)
340 = f x 0.068 (1 mark)
f = 5000 Hz (1 mark)</td></tr>
<tr><td>11a</td><td>One answer from:</td><td>photodiode | phototransistor | thermistor | LDR
thermocouple | thermopile | CCD</td></tr>
<tr><td>11b</td><td>0.90 Hz</td><td>70% of infrared light received falls in the medium category
 

Medium category gives 54 Wipes per minute
Number of Raindrops	No. of times wipers move back and forth per minute
Low	18
Medium	54
High	78

Calculation of frequency
N = 54 (1mark)
$f = \frac{N}{t}$ (1mark)
$f = \frac{54}{60}$ (1mark)
f = 0.90 Hz</td></tr>
<tr><td>11c(i)A</td><td>Normal drawn as shown in diagram</td><td rowspan="2"> 
</td></tr>
<tr><td>11c(i)B</td><td>Angle of incidence and angle of refraction drawn as shown in diagram</td></tr>
<tr><td>11c(ii)</td><td>Answer to include:</td><td>1 mark | Wavelength in water is greater than in glass
1 mark | Speed of light in water is greater than in glass</td></tr>
<tr><td>12a</td><td>One answer from:</td><td>Fast electron | high-energy electron | An electron from the nucleus</td></tr>
<tr><td>12b</td><td>Answer to include:</td><td>1 mark | Activity of tritium source is less or Fewer beta particles emitted per second
1 mark | Less light produced</td></tr>
</table>

<table>
<tr><td>12c(i)</td><td>0.034 J</td><td>D = 0.40 mGy = 0.40×10^{-3} Gy E = ? m = 85kg
$D = \frac{E}{m}$ (1 mark)
$0.40\times10^{-3} = \frac{E}{85}$ (1 mark)
E = 0.034 J (1 mark)</td></tr>
<tr><td>12c(ii)</td><td>4.0×10^{-4} Sv</td><td>H = ? D = 0.40 mGy = 0.40×10^{-3} Gy $w_r = 1$
H = D x W_r (1 mark)
H = 0.40×10^{-3} x 1 (1 mark)
H = 4.0×10^{-4} Sv (1 mark)</td></tr>
<tr><td>13a(i)</td><td>One answer from:</td><td>The counter reading will include the source and background count | Background will need to be subtracted | To measure/determine the count rate due to the source</td></tr>
<tr><td>13a(ii)</td><td>Any suitable source</td><td></td></tr>
<tr><td>13b(i)</td><td>Line graph showing:</td><td>Suitable scales, labels and units | All points plotted Accurately to ± half a division | Best fit curve</td></tr>
<tr><td>13b(ii)</td><td>30 minutes</td><td>Take any halving on the Corrected Count Rate axis and extrapolate the time taken from these point on the Time axis</td></tr>
<tr><td>13c(i)</td><td>Answer to include:</td><td>1 mark: Reduce the distance between the detector and the source
1 mark: Alpha is absorbed by a few cm of air/range in air is a few cm. or Alpha has a shorter rang than Gamma</td></tr>
<tr><td>13c(ii)</td><td>7800</td><td>A = 520 Bq N = ? t = 15s
$A = \frac{N}{t}$ (1 mark)
$520 = \frac{N}{15}$ (1 mark)
N = 7800 (1 mark)</td></tr>
</table>