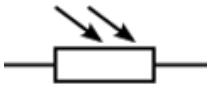
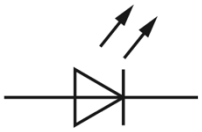
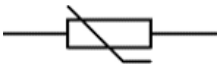
Past Papers
Nat 5
Physics
2016
Marking Scheme

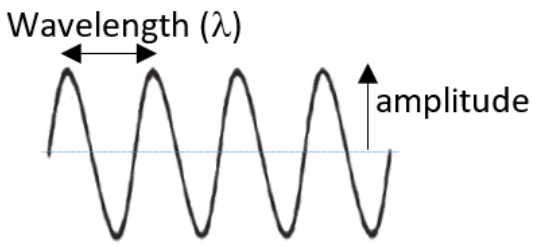
Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	69+	31.3%
B	58+	23.5%
C	48+	19.1%
D	43+	8.1%
No award	<43	17.9%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	12.7 /20	32.9 /60	13.2 /20

2016 Nat5 Physics Marking Scheme

<table>
<tr><th>Question</th><th>Answer</th><th>Physics Covered</th></tr>
<tr><td>1</td><td>C</td><td>
<table>
<tr><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>LDR</td><td>Transistor</td><td>LED</td><td>Photovoltaic cell</td><td>Thermistor</td></tr>
<tr><td>  </td><td>  </td><td>  </td><td></td><td>  </td></tr>
</table>
</td></tr>
<tr><td>2</td><td>A</td><td>☑A A negative particle will bend towards a positively charged plate
☒B A negative particle will not bend towards a negatively charged plate
☒C Particles with no charge will not deflect in a uniform electric field
☒D Particles with no charge will not deflect in a uniform electric field
☒E A positive particle will not bend towards a positively charged plate</td></tr>
<tr><td>3</td><td>D</td><td>$A_1 = A_2 + A_3 \quad \therefore \mathbf{A_3} = A_1 - A_3 = 5.0\text{ A} - 2.0\text{ A} = \mathbf{3.0\text{ A}}$
$A_1 = A_4 + A_5 \quad \therefore \mathbf{A_5} = A_1 - A_4 = 5.0\text{ A} - 1.0\text{ A} = \mathbf{4.0\text{ A}}$</td></tr>
<tr><td>4</td><td>C</td><td>$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{R_T} = \frac{1}{8} + \frac{1}{24}$
$\frac{1}{R_T} = \frac{4}{24}$
$R_T = 6\ \Omega$</td></tr>
<tr><td>5</td><td>B</td><td>Minimum pressure exerted would be from the side of block with largest area.
$\therefore$ Largest Area = l x b = 0.2 x 0.1 = 0.02 m^2
P = ? F = 4.9 N A = 0.02 m^2
$P = \frac{F}{A} = \frac{4.9}{0.02} = 245$ Pa</td></tr>
<tr><td>6</td><td>C</td><td>Temperature: Constant $p_1 = 120$ kPa $V_1 = 150$ mm^3
$p_2 = ?$ $V_2 = 100$ mm^3
$p_1V_1 = p_2V_2$
$120 \times 150 = p_2 \times 100$
$\frac{120 \times 150}{100} = p_2$
$180\text{ kPa} = p_2$</td></tr>
<tr><td>7</td><td>A</td><td>☑A temperature-pressure gives a straight line on graph which does not go through origin in °C
☒B If temperature scale is measured in Kelvin then line will go through origin on graph
☒C Graph does not show an increase in temperature giving a increase in pressure
☒D Graph does not show an increase in temperature giving a increase in pressure
☒E If temperature scale is measured in °C then line will not go through origin on graph</td></tr>
<tr><td>8</td><td>A</td><td>
<table>
<tr><td>Statement I - Correct</td><td>Statement II - Incorrect</td><td>Statement III - Incorrect</td></tr>
<tr><td>Waves are capable of transferring energy. In a transverse wave the higher the amplitude of a wave the more energy is transferred</td><td>Long waves diffract/bend more than shorter wavelengths</td><td>The amplitude is independent of the wavelength</td></tr>
</table>
</td></tr>
</table>

9 — E

<u>frequency</u> (f) number of waves that pass a point in one second.	
<u>wavelength</u> (λ) horizontal distance between any two corresponding points on adjacent waves.	
<u>amplitude</u> vertical distance measured from the middle of the wave to the top or to the bottom	

10 — C

Speed of Waves: $v = \frac{d}{t} = \frac{3}{3} = 1 \text{ m s}^{-1}$

Frequency: $f = \frac{N}{t} = \frac{3}{3} = 1 \text{ Hz}$

11 — A

☑ A Angles of refraction correct direction of bend and rays in air are parallel
☒ B Angle of reaction in 1st glass bends wrong way as glass denser than air.
☒ C Angle of ray in middle air section should be parallel to angle going in 1st glass
☒ D Angle of refraction in both glass is wrong as they are equal to the normal
☒ E Angle of ray between glass layers should be parallel to angle of original ray

12 — B

Particle	Nature of Particle	Mass	Charge
Alpha Particle	Helium Nucleus	Larger	Positive
Beta Particle	Electron from the Nucleus	Smaller	Negative

13 — B

Ionising radiation can cause atoms to become charged ions.

Ion Formed	Positive Ion	Negative Ion
Change to form Ion	Loss of electron	Gain of electron

When forming an ion, electrons are lost or gained by the atom. The number of protons stays the same as it would take a nuclear reaction to change the number of protons.

14 — E

Vector Quantity	force	velocity	displacement	**acceleration**	weight
Scalar Quantity	energy	speed	distance	time	mass

15 — D

☒A Ball will accelerate down the slope at Q which would give a uphill straight line at end of graph
☒B Ball will accelerate down the slope at Q which would give a uphill straight line at end of graph
☒C Ball will accelerate down the slope at Q which would give a uphill straight line at end of graph
☑D Graph is horizontal at P as bal has constant speed and uphill straight line at Q as it accelerates.
☒E Ball has constant velocity at P so graph will be horizontal in first section of graph

16 — D

E_k = ? m = 80kg v = 10 m s^{-1}

$E_k = \frac{1}{2} mv^2 = \frac{1}{2} \times 80 \times (10)^2$

$E_k = \frac{1}{2} \times 80 \times 100$

$E_k = 4000 \text{ J}$

17 — E

☒A The Earth is not in contact with the exhaust gases so there is no reaction force from the Earth.
☒B The Earth is not in contact with the rocket engine so there is no reaction force from the Earth.
☒C The rocket engines are not in contact with Earth so no reaction force
☒D The exhaust gases are not in contact with the Earth so no reaction force
☑E The reaction force is the force of the exhaust gases on the rocket engines

18 — C

☒A Horizontal velocity will still be 1.5 m s^{-1} as there is negligible air resistance and does not slow down
☒B Horizontal velocity will still be 1.5 m s^{-1} as there is negligible air resistance and does not slow down
☑C vertical velocity $v_v = u_v + at = 0 + (9.8 \times 1.2) = 11.76 = 12 \text{ m s}^{-1}$. Horizontal velocity = 1.5 m s^{-1}
☒D vertical velocity $v_v = u_v + at = 0 + (9.8 \times 1.2) = 11.76 = 12 \text{ m s}^{-1}$
☒E Horizontal velocity will still be 1.5 m s^{-1} as there is negligible air resistance and does not slow down

19 — D

E = ? m = 0.5 kg $l = 22.6 \times 10^5 \text{ J kg}^{-1}$

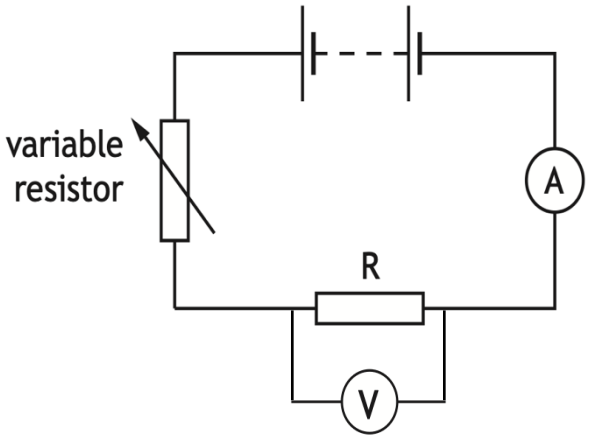
$E = m \times l$

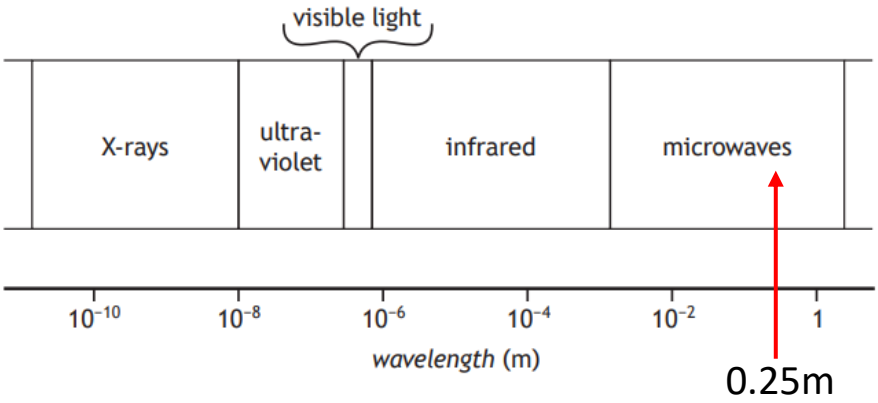
$E = 0.5 \times 22.6 \times 10^5$

$E = 1.13 \times 10^6 \text{ J}$

20 — D

Statement I - **Correct**	Statement II - Incorrect	Statement III - **Correct**
The Big Bang theory is a theory about the origin of the universe	The universe is approximately 14 *billion* years old	The universe is always expanding

Question	Answer	Physics Covered
1a	20000 A	Q = 24 C I = ? t = 0.0012 s Q = I t (1 mark) 24 = I x 0.0012 (1 mark) I = 20000A (1 mark)
1b	1.5×10^{20}	1.6×10^{-19} C = 1 electron $24\ C = 1\ \text{electron} \times \frac{24\ C}{1.6 \times 10^{-19}\ C}$ $= 1.5 \times 10^{20}$ electrons
1c	Answer to include:	1 mark: metal strip is a conductor 1 mark: more current will pass through the strip than building
2a	Voltmeter across resistor R	
2b	One answer from:	increase / decrease / vary / change — the resistance of the variable resistor
2c	Calculations showing: Or Graph Showing:	V = I R; 1 = 0.2 x R; R = 5Ω V = I R; 2.5 = 0.5 x R; R = 5Ω V = I R; 3.2 = 0.64 x R; R = 5Ω V = I R; 6.2 = 1.24 x R; R = 5Ω 1 mark: Ohm's Law Stated 2 marks: All Substitutions shown 1 mark: 5Ω 1 mark: Suitable scales & labels 2 marks: All points plotted accurately 1 mark: Line drawn and gradient calculated to be 5Ω
2d	Answer to include:	Resistance is changing / not constant / Increasing
3a	Working showing: 627000J	E = ? c = 4180 kJ kg^{-1} °C^{-1} m = 6.00 kg ΔT = 40°C – 15°C = 25°C E = c m ΔT (1 mark) E = 4180 x 6.00 x 25 (1 mark) E = 627000 J
3b(i)	350 s	P = 1800 W E = 627000 J t = ? $P = \frac{E}{t}$ (1 mark) $\therefore\ 1800 = \frac{627000}{t}$ (1 mark) $\therefore\ t = \frac{627000}{1800} = 350$ s (1 mark)

<table>
<tr><td>3b(ii)</td><td>One answer from:</td><td>Heat (energy) is lost (from the water) to the { washing machine / drum / surroundings / clothing }
or
Some of the energy is used to heat up the { washing machine / drum / element / clothing }</td></tr>
<tr><td>3c</td><td>Answer to include:</td><td><table><tr><td>1 mark</td><td>Voltage across thermistor decreases</td></tr><tr><td>1 mark</td><td>MOSFET/transistor switches off/deactivates</td></tr><tr><td>1 mark</td><td>Relay switches off/relay switch opens/relay deactivates</td></tr></table></td></tr>
<tr><td>4a</td><td>One answer from:</td><td><table><tr><td rowspan="2">(black bulb)
thermometer</td><td>photodiode</td><td>phototransistor</td><td>thermistor</td></tr><tr><td>CCD</td><td>thermochromic film</td><td>thermocouple</td></tr></table></td></tr>
<tr><td>4b</td><td>Gamma</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 colspan="2">High</td><td colspan="4">←——→</td><td>Low</td></tr><tr><td>Frequency</td><td colspan="2">High</td><td colspan="4">←——→</td><td>Low</td></tr><tr><td>Wavelength</td><td colspan="2">Low</td><td colspan="4">←——→</td><td>High</td></tr></table></td></tr>
<tr><td>4c(i)</td><td>0.25m</td><td>$\nu = 3x10^8$ m s^{-1} f = 1.2GHz = $1.2x10^9$ Hz λ = ?
$\nu = f \times \lambda$ (1 mark)
$3x10^8 = 1.2x10^9 \times \lambda$ (1 mark)
$\lambda = 0.25$m</td></tr>
<tr><td>4c(ii)</td><td>microwave</td><td> 
</td></tr>
<tr><td>5</td><td>Answer to include:</td><td><table><tr><th>1 mark</th><th>2 marks</th><th>3 marks</th></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>
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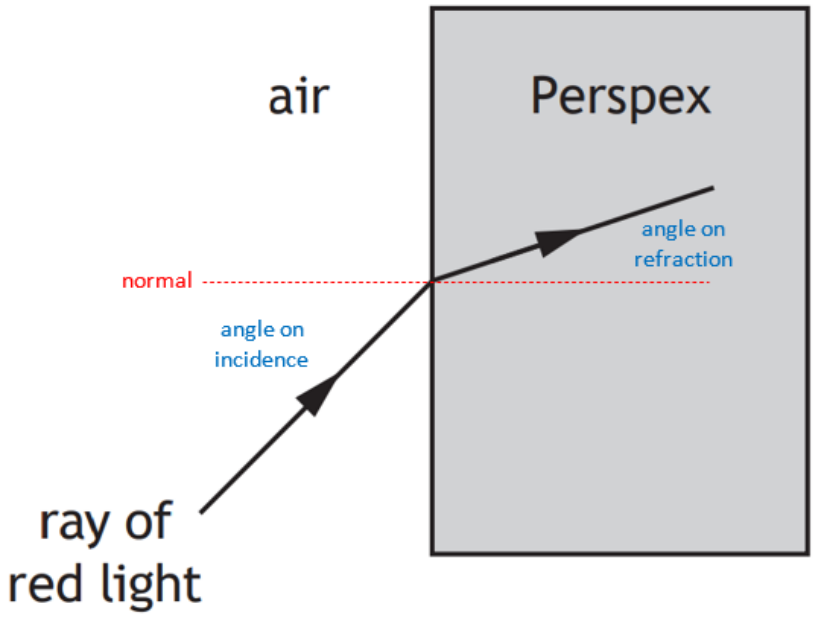
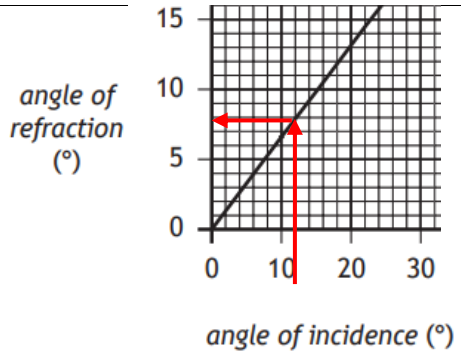
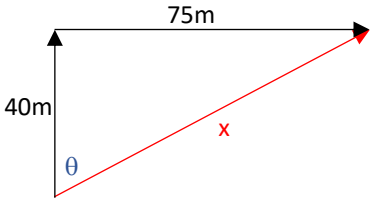
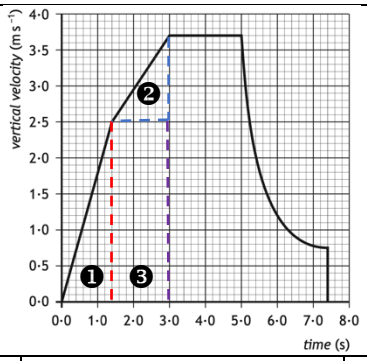
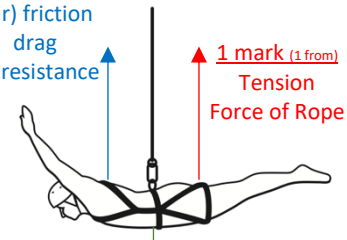
<table>
<tr><td>6a(i)</td><td>Normal as drawn in Diagram</td><td rowspan="2"> 
</td></tr>
<tr><td>6a(ii)</td><td>Angles of Incidence and angle of refraction as drawn in diagram</td></tr>
<tr><td>6b(i)</td><td>8°</td><td> 
</td></tr>
<tr><td>6b(ii)</td><td>Any angle between 40° and 42°
(inclusive)</td><td>Extrapolate the curve until it hits 80° on the angle of incidence axis and read the angle of refraction axis.</td></tr>
<tr><td>6c</td><td>Any Answer from:</td><td><table><tr><td>To obtain more reliable results</td><td>Eliminate rogue results/outliers</td><td>To allow an average/mean to be calculated</td><td>More accurate</td></tr></table></td></tr>
<tr><td>7a</td><td>8.8 x 10^{15} Bq</td><td>A = ? N = 7.92x10^{18} nuclei decayed t = 15min = 15x60s = 900s
$A = \frac{N}{t} = \frac{7.92\times10^{18}}{900} = 8.8\times10^{15}$ Bq
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>7b</td><td>400W</td><td>Heat Generation = No. of decays x 4.49x10^{-14} (1 mark)
= 400W (1 mark)</td></tr>
<tr><td>7c</td><td>One answer from:</td><td><table><tr><td>Alpha is more easily absorbed/stopped/blocked</td><td>Alpha is less penetrating than gamma</td><td>Gamma is more penetrating than Alpha</td></tr><tr><td colspan="2">Alpha is absorbed by thinner materials/less dense materials.</td><td>Gamma is absorbed by thicker materials/more dense materials.</td></tr></table></td></tr>
<tr><td>8a(i)</td><td>1.9 x10^{-4} Gy</td><td>D = ? E = 9.6x10^{-5} J m = 0.50kg
$D = \frac{E}{m}$ (1 mark)
$D = \frac{9.6\times10^{-5}}{0.50}$ (1 mark)
D = 1.9 x 10^{-4} Gy (1 mark)</td></tr>
<tr><td>8a(ii)</td><td>1.9 x10^{-4} Sv</td><td>H = ? D = 1.9 x 10^{-4} Gy w_R = 1
H = D x w_R (1 mark)
H = 1.9 x 10^{-4} x 1 (1 mark)
H = 1.9 x 10^{-4} Sv (1 mark)</td></tr>
</table>

<table>
<tr><td>8b</td><td>0.75kBq
or
750 Bq</td><td>No. of half-lives = $\frac{144}{36}$ = 4 (1 mark)
Halving of activity (1 mark)
12 → 6 → 3 → 1.5 → 0.75 kBq (1 mark)</td></tr>
<tr><td>9a(i)</td><td>85 m</td><td>Vertical displacement = 54m – 14m = 40m Horizontal
 
$x = \sqrt{(75)^2 + (40)^2}$
$x = \sqrt{5625 + 1600}$
$x = \sqrt{7225}$
$x = 85$ m</td></tr>
<tr><td>9a(ii)</td><td>062
or
62° East of North</td><td>$\tan\theta = \frac{opp}{adj}$ ∴ $\tan\theta = \frac{75}{40} = 1.875$ ∴ θ = 62° = 062
(1 mark) (1 mark)</td></tr>
<tr><td>9b(i)</td><td>1.3m s^{-1} at bearing 062</td><td>$\bar{v}$ = ? s = 85 m t = 68 s
s = $\bar{v}$ t (1 mark)
85 = $\bar{v}$ x 68 (1 mark)
$\bar{v}$ = 1.3 m s^{-1} (1 mark)
Average velocity $\bar{v}$ = 1.3 m s^{-1} at bearing 062</td></tr>
<tr><td>9b(ii)</td><td>1 mark
distance is greater than displacement
1 mark
same time</td><td>The distance travelled is greater than the displacement as in the vertical direction.The student walks back 14m and this 14m is subtracted from the 54m to work out the displacement. 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>10a</td><td>1.8 m s^{-2}</td><td>a = ? v = 2.5 m s^{-1} u = 0 m s^{-1} t = 1.4 s
$a = \frac{v - u}{t} = \frac{2.5 - 0}{1.4} = 1.8$ m s^{-2}
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>10b</td><td>6.71 m</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>= ½ x 1.4 x 2.5</td><td>= ½ x 1.6 x 1.2</td><td>= 1.6 x 2.5</td></tr>
<tr><td>= 1.75</td><td>= 0.96</td><td>= 4</td></tr>
<tr><td colspan="3">Total Distance travelled in first 3.0s. = 1.75m + 0.96m + 4m = 6.71m</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>10c</td><td>labelled diagram showing:</td><td><u>1 mark</u> (1 from)
(air) friction
drag
air resistance
<u>1 mark</u> (1 from)
Tension
Force of Rope
 
<u>1 mark</u> (1 from)
force of gravity
weight</td></tr>
<tr><td>11</td><td>Answer to include:</td><td>
<table>
<tr><th>1 mark</th><th>2 marks</th><th>3 marks</th></tr>
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</td></tr>
<tr><td>12a</td><td>2.9×10^4 N</td><td>W = ? m = 3.00×10^3 kg g = 9.8 N kg^{-1}
W = m g (1 mark)
W = 3.00×10^3 x 9.8 (1 mark)
W = 2.9×10^4 N (1 mark)</td></tr>
<tr><td>12b(i)</td><td>light → electrical
energy energy</td><td>Photovoltaic cells are solar cells that turn light energy into electrical energy</td></tr>
<tr><td>12b(ii)</td><td>Maximise the light received
(from the Sun)</td><td>Photovoltaic Cells work best when the solar cells are perpendicular to the sun. The greater the angle sunlight hits the panels the lower the voltage produced.</td></tr>
<tr><td>12b(iii)</td><td>2.8×10^6 J</td><td>E = ? P = 395 W t = 2 Hours = 2x60x60 s
E = P t (1 mark)
E = 395 x 2x60x60 (1 mark)
E = 2.8×10^6 J (1 mark)</td></tr>
<tr><td>12c(i)</td><td>40 N</td><td>Four 10 N thrusters pushing in same direction gives total thrust = 40 N</td></tr>
<tr><td>12c(ii)</td><td>0.02 m s^{-2}</td><td>m = 3.00×10^3 kg – 1.00×10^3 kg = 2.00×10^3 kg (1 mark)
a = ? F = 40 N m = 2.00×10^3 kg
$a = \frac{F}{m} = \frac{40}{2.00\times10^3} = 0.02$ m s^{-2}
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>13a</td><td>Nuclei combine to form larger nucleus</td><td>Nuclear fusion is the combining of two smaller nuclei into a larger nucleus with a greater mass. Energy can be released in the process.</td></tr>
<tr><td>13b</td><td>5505 K</td><td>Temperature in °C = Temperature in K – 273K = 5778K – 273K = 5505K</td></tr>
<tr><td>13c</td><td>working showing 4.1×10^{16} m</td><td>d = v x t (1 mark)
d = 3×10^8 (1 mark) x 640 x 365.25 x 24 x 60 x 60 (1 mark)
d = 4.1×10^{16} m</td></tr>
<tr><td>13d</td><td>One answer from:</td><td>The light/radiation from the explosion has not reached the Earth yet <u>or</u> The light radiation takes time 640 years to reach Earth</td></tr>
</table>