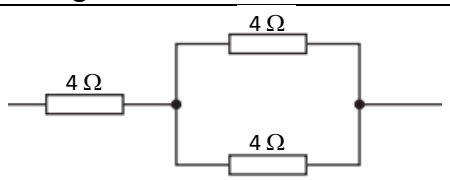
Past Papers
Nat 5
Physics
2015
Marking Scheme

Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	68+	28.9%
B	58+	23.3%
C	48+	21.8%
D	43+	8.5%
No award	<43	17.4%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	13.0 /20	32.1 /60	12.7 /20

2015 Nat5 Physics Marking Scheme

<table>
<tr><th>Question</th><th>Answer</th><th>Physics Covered</th></tr>
<tr><td>1</td><td>A</td><td>
<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>Ohmmeter
measuring resistance</td><td>Voltmeter
measuring voltage</td><td>Ammeter
measuring current</td></tr>
<tr><td>Ohmmeter is placed in series with component. No cell required.</td><td>Voltmeters are place in parallel around the component being measured</td><td>Ammeters are connected in series in a circuit.</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>A</td><td>
<table>
<tr><th>Statement I - Correct</th><th>Statement II - Incorrect</th><th>Statement III - Incorrect</th></tr>
<tr><td>Voltage is defined as a measure of the energy given to the charge carriers in a circuit</td><td>A cell or battery has a voltage at all times whether connected in a circuit or unconnected.</td><td>Electrons are free to move in a conductor</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>C</td><td>
<table>
<tr><th>Combining Parallel Resistors:</th><th>Combining Series Resistors:</th></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{R_T} = \frac{1}{4} + \frac{1}{4}$
$\frac{1}{R_T} = \frac{2}{4}$
$R_T = 2\,\Omega$</td><td>$R_T = R_1 + R_2 = 4\Omega + 2\Omega =$ 6 Ω</td></tr>
</table>
</td></tr>
<tr><td>4</td><td>E</td><td>$P = \frac{V^2}{R} \therefore 920 = \frac{(230)^2}{R} \therefore R = \frac{52900}{920} = 57.5\Omega$</td></tr>
<tr><td>5</td><td>B</td><td>☒A There is no change in Temperature so there is no change in Kinetic Energy
☑B Increase in pressure means more air particles hit the sides of the syringe
☒C There are more collisions with the sides of the syringe when pressure is increased
☒D There are less collisions with the sides of the syringe when pressure is decreased
☒E There is no change in Temperature so there is no change in Kinetic Energy</td></tr>
<tr><td>6</td><td>D</td><td>Volume: Constant
$p_1 = 150$ kPa $T_1 = 27^oC = 300$ K
$p_2 = ?$ $T_2 = 47^oC = 320$ K
$\frac{p_1}{T_1} = \frac{p_2}{T_2}$
$\frac{150}{300} = \frac{p_2}{320}$
$p_2 = \frac{150 \times 320}{300}$
$p_2 = 160$ kPa</td></tr>
<tr><td>7</td><td>D</td><td>3 complete waves = 3 wavelengths = 18mm
= 1 wavelength = 6mm</td></tr>
<tr><td>8</td><td>A</td><td>
<table>
<tr><th>Statement I - Correct</th><th>Statement II - Incorrect</th><th>Statement III - Incorrect</th></tr>
<tr><td>Light waves are transverse waves. All forms of electromagnetic radiation are transverse waves</td><td>Radio waves travel at $3x10^8$m s^{-1} like all other forms of electromagnetic radiation. Sound waves travel at 340m s^{-1}</td><td>
<table>
<tr><th>EM Type</th><th>Gamma</th><th>X-Ray</th><th>Ultra-violet</th><th>Visible</th><th>Infra-Red</th><th>Microwave</th><th>Radio & TV</th></tr>
<tr><td>Energy</td><td colspan="6">High ◄——► Low</td></tr>
<tr><td>Frequency</td><td colspan="6">High ◄——► Low</td></tr>
<tr><td>Wavelength</td><td colspan="6">Low ◄——► High</td></tr>
</table>
</td></tr>
</table>
</td></tr>
<tr><td>9</td><td>C</td><td>Ionising describes the process where atoms lose electrons and become positively charged
or
atoms gain electrons and become negatively charged</td></tr>
</table>

10 — E

Statement I - **Correct**	Statement II - **Incorrect**	Statement III - **Correct**
Shielding of tissue with a lead screen will reduce the equivalent dose received	Increasing the distance from the source will <u>reduce</u> the equivalent dose received by the tissue	Increasing the time of exposure will increase the equivalent dose received by the tissue

11 — E

H = ? D = 16μGy = 16×10^{-6} Gy $w_R = 20$

H = D x w_R

H = 16×10^{-6} x 20

H = 320×10^{-6} Sv

= 320 μSv

12 — A

A = ? N = 240 t = 1 minute = 60s

$$A = \frac{N}{t} = \frac{240}{60} = 4 \text{ Bq}$$

13 — E

X	Y	Z
Fusion Nuclear fusion occurs when two smaller nuclei join together to make a bigger nuclei	**Fission** Nuclear fission occurs when a larger nuclei spits into two smaller nuclei	**Energy** The release of energy in fission and fusion reactions can be used as an energy source.

14 — C

Vector quantities have magnitude <u>and</u> direction while scalar quantities only have magnitude.

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

15 — B

Statement I - Incorrect	Statement II - **Correct**	Statement III - Incorrect
X is accelerating as its velocity is increasing by 2 m s^{-1} every second	Y is undergoing constant acceleration as velocity is increasing by 1 m s^{-1} every second	Z is *not* undergoing constant acceleration as the velocity is not increasing by same amount every second.

16 — C

E_w = ? F = 2500N d = 50m

E_w = F d

E_w = 2500 x 50

E_w = 125000 J

17 — A

☑A The reaction force is the chair on the person
☒B This is the same force not the reaction force
☒C The person is not touching the Earth directly so there is no reaction force of the Earth on the person
☒D The force of the chair on Earth is not the reaction force to the person sitting on the chair
☒E The person is not directly applying force to Earth as the chair is applying the force on Earth

18 — B

Statement I - Incorrect	Statement II - **Correct**	Statement III - Incorrect
At terminal velocity the weight of the balance is equal to the air resistance acting on the passage	As terminal velocity, the object is travelling at constant velocity indicating forces are balanced	The object is travelling at a constant velocity at terminal velocity so not accelerating

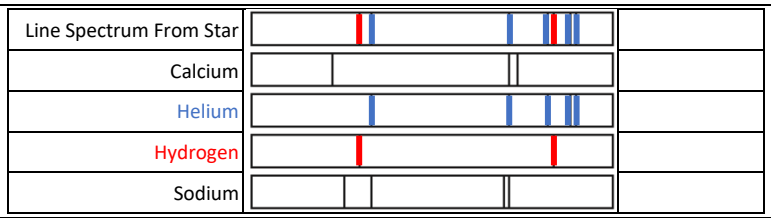
19 — E

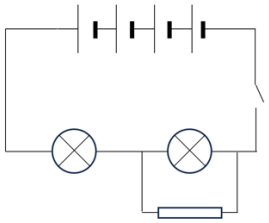
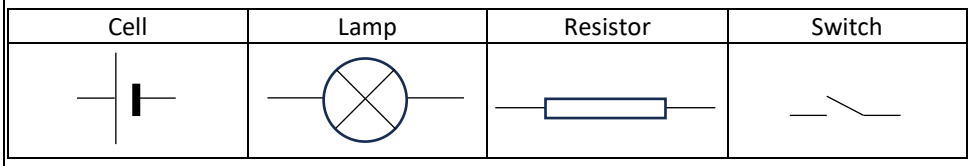
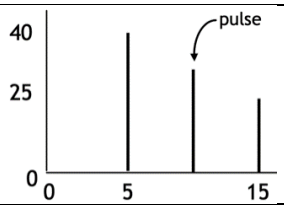
d = ν x t

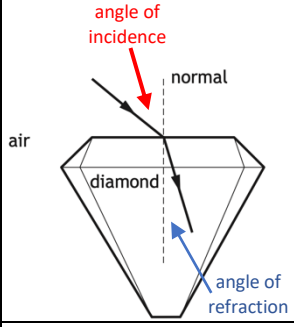
d = 3×10^{8} x 4.3 x 365.25 x 24 x 60 x 60

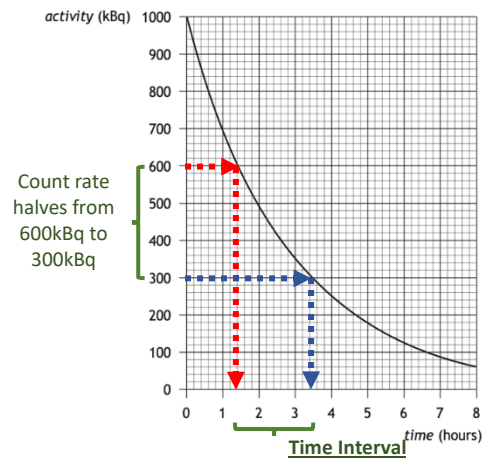
d = 4.1×10^{16} m

20 — D



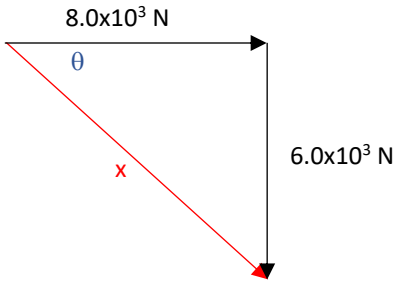
Question	Answer	Physics Covered
1a		
1b	5 Ω	V = 2.5 V I = 0.5 A R = ? V = I R (1 mark) 2.5 = 0.5 x R (1 mark) R = 5 Ω (1 mark)
1c	Answer to include:	Effect (1 mark): (1 mark) (lamp L/it is) **brighter** Justification (2 marks): (1 mark) M is in parallel (with resistor); (1 mark) Greater current in/through lamp L (than that in M) or Greater voltage across lamp L (than across M)
2a	1 mark: Graph X 1 mark: LED only conducts in one direction	LED are light emitting diodes only conduct electricity in on direction in a circuit. Graphs Y & Z can be ruled out as they show that electricity flowing in both directions. Graph X has a positive voltage & current but has no negative voltage & current indicating current flowing in one direction only.
2b(i)	120 J	P = ? V = 4.0 V I = 0.50A P = V I (1 mark) P = 4.0 x 0.50 P = 2.0 W P = 2.0 W E = ? t = 60 s $P = \frac{E}{t}$ ∴ $2.0 = \frac{E}{60}$ ∴ E = 2.0 x 60 = 120 J (1 mark) (1 mark) (1 mark)
2b(ii)	30 C	Q = ? I = 0.50A t = 60s Q = I t (1 mark) Q = 0.5 x 60 Q = 30 C
3a(i)	15ms	Position Y is thinner than position X. Position Y will reflect pulse first at 5ms and position X will reflect pulse second at 15ms
3a(ii)	0.039m	d = ? v = 5200m s^{-1} t = 15ms = 15x10^{-6}s d = v x t (1 mark) d = 5200 x 15x10^{-6} (1 mark) d = 0.0078m (1 mark) Thickness = $\frac{0.078}{2}$ = 0.039m (1 mark)
3b		1 mark: Vertical line between 5 and 15 on x-axis 1 mark: Amplitude between 25 and 40 on y-axis The imperfection at Position Z is between the thickness at Positions X and Y meaning the time taken and amplitude of the reflected pulse will be between the values at Position X and Y
3c(i)	2.5x10^5 Hz or 250,000Hz	f = ? T = 4.0μs = 4x10^{-6}s $f = \frac{1}{T}$ (1 mark) $f = \frac{1}{4x10^{-6}}$ (1 mark) f = 2.5x10^5 Hz

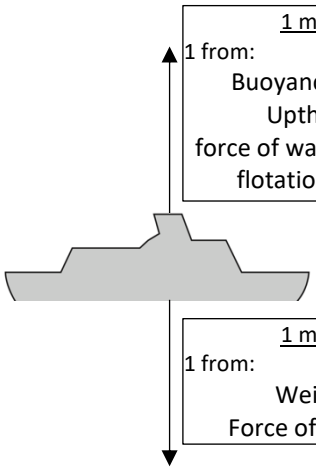
<table>
<tr><td>3c(ii)</td><td>0.021 m</td><td>$v = 5200\ m\ s^{-1}$ $f = 2.5x10^{-5}\ Hz$ $\lambda = ?$
$v = f \times \lambda$ (1 mark)
$5200 = 2.5x10^{-5} \times \lambda$ (1 mark)
$\lambda = 0.021\ m$ (1 mark)</td></tr>
<tr><td>3d</td><td>Answer to include:</td><td><table><tr><td>1 mark</td><td>Speed of ultrasound in brass is less than in steel</td></tr><tr><td>1 mark</td><td>Takes greater time to travel same distance/thickness.</td></tr></table></td></tr>
<tr><td>4</td><td>Open Ended Question</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>
<tr><td>5a</td><td> 
</td><td>Angle of incidence is measured from the normal to the light ray going into the diamond

Angle of refraction is measured from the normal to the light ray inside the diamond</td></tr>
<tr><td>5b</td><td>Decreases</td><td>When light passes into a diamond the speed of light decreases</td></tr>
<tr><td>5c</td><td>B</td><td>The higher the optical density the higher the degree of refraction.
This leads to a greater bending of light towards to the normal so the angle of refraction would be the smallest with the greater degree of refraction</td></tr>
<tr><td>5d</td><td>$5.5x10^{9}$ Pa</td><td>$P = ?$ $F = 61\ kN = 61000N$ $A = 1.1x10^{-5}\ m^2$
$P = \frac{F}{A} = \frac{61000}{1.1x10^{-5}} = 5.5x10^{9}\ Pa$
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>6a</td><td>increases</td><td>The thicker the paper the lower the quantity of radiation that can cross the paper.
By making the paper thinner then the quantity of radiation crossing the paper will increase.</td></tr>
<tr><td>6b(i)</td><td>Answer to include:</td><td><table><tr><td>Choice of Radioactive Source</td><td colspan="2">Explanation</td></tr><tr><td>X</td><td>Beta Source Required</td><td>Long half-life</td></tr><tr><td>(1 mark)</td><td>(1 mark)</td><td>(1 mark)</td></tr></table></td></tr>
<tr><td>6b(ii)</td><td>One answer from:</td><td><table><tr><td>Time for activity to (decrease by) half</td><td>Time for half the nuclei to decay</td></tr></table></td></tr>
<tr><td>6b(iii)</td><td>(high frequency) electromagnetic wave</td><td>Gamma radiation is one form of electromagnetic radiation:
<table><tr><th>EM Type</th><th>Gamma</th><th>X-Ray</th><th>Ultra-violet</th><th>Visible</th><th>Infra-Red</th><th>Microwave</th><th>Radio & TV</th></tr><tr><td>Energy</td><td colspan="6">High ← → Low</td></tr><tr><td>Frequency</td><td colspan="6">High ← → Low</td></tr><tr><td>Wavelength</td><td colspan="6">Low ← → High</td></tr></table></td></tr>
<tr><td>6c</td><td>2 hours</td><td> 

Take any halving of the corrected count rate on the y-axis.

Work out the time interval on the x-axis for this halving.</td></tr>
</table>

<table>
<tr><td>7a(i)</td><td>10x10^3 N
or
1.0x10^4 N
or
10000 N</td><td> 

$x = \sqrt{(6000)^2 + (8000)^2}$
$x = \sqrt{36000000 + 64000000}$
$x = \sqrt{100000000}$
x = 10000 km = 10x10^3 km = 1x10^4 km</td></tr>
<tr><td>7a(ii)</td><td>37°</td><td>$\tan\theta = \frac{\text{opp}}{\text{adj}} = \frac{6.0\text{x}10^3}{8.0\text{x}10^3} = 0.75 \quad \therefore \ \theta = 37°$</td></tr>
<tr><td>7a(iii)</td><td>2x10^{-3} m s^{-2}</td><td>F = 10x10^{3}N m = 5.0x10^6 kg a = ?
F = m a (1 mark)
10x10^3 = 5.0x10^6 x a (1 mark)
a = 2.0x10^{-3} m s^{-2} (1 mark)</td></tr>
<tr><td>7b</td><td>Answer to include:</td><td> 

1 mark
(These) forces are balanced</td></tr>
<tr><td>8a(i)</td><td>Answer to include:</td><td><table><tr><td>1 mark
length/width of card</td><td>1 mark
time taken for card to pass (through) the light gate</td><td>1 mark
time taken (for trolley to travel from starting position) to light gate</td></tr></table></td></tr>
<tr><td>8a(ii)</td><td>One answer from:</td><td><table><tr><td>reaction time
(can cause error with the stop clock reading)</td><td>card may not have passed straight through light gate</td><td>length/width of card not measured properly
(e.g. ruler not straight along card)</td><td>other suitable reason</td></tr></table></td></tr>
<tr><td>8b</td><td>0.64 m s^{-2}</td><td>a = ? v = 1.6 m s^{-1} u = 0 m s^{-1} t = 2.5 s
$a = \frac{v - u}{t} = \frac{1.6 - 0}{2.5} = 0.64$ m s^{-2}
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>9a</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>9b(i)</td><td>7.8 m s^{-1}</td><td>a = 9.8 m s^{-2} v = ? u = 0 m s^{-1} t = 0.80 s
$a = \frac{v - u}{t}$ (1 mark)
$9.8 = \frac{v - 0}{0.80}$ (1 mark)
9.8 x 0.80 = v − 0
7.8 m s^{-1} = v (1 mark)</td></tr>
</table>

9b(ii) — 3.1 m

$\bar{v}$ = ? $u = 0\ m\ s^{-1}$ $v = 7.8\ m\ s^{-1}$

$$\bar{v} = \frac{u + v}{2} = \frac{0 + 7.8}{2} = \frac{7.8}{2} = 3.9\ m\ s^{-1}$$ (1 mark)

d = ? $\bar{v} = 3.9\ m\ s^{-1}$ $t = 0.80\ s$

d = $\bar{v}$ t (1 mark)

d = 3.9 x 0.80 (1 mark)

d = 3.1 m (1 mark)

9c — same time

The time taken for a stone to hit the water when dropped vertically is the same as the time taken when thrown horizontally as the vertical component is subject to the same acceleration due to the gravitational field strength being the same.

10 — Open Ended Question

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.

11a(i) — 0.20 J

E_p = ? m = 0.040kg g = 9.8 N kg^{-1} h = 0.50m

E_p = m g h (1 mark)

E_p = 0.040 x 9.8 x 0.50 (1 mark)

E_p = 0.20 J (1 mark)

11a(ii) — One answer from:

kinetic energy to heat (and sound)	kinetic energy of marble to kinetic energy of sand.

11b(i) — Graph showing:

1 mark	1 mark	1 mark
suitable scales, labels and units	all points plotted accurately to ± half a division	best fit curve

11b(ii)

11b(iii) — Any two from:

1 mark for each answer:				
Repeat (and average)	Take (more) readings in the 0·15m to 0·35m drop height range	Increase the height range	level sand between drops	or other suitable improvement

11c(i) — One variable from:

mass/weight of marble	angle of impact	diameter of marble	type of sand	
radius of marble	density of marble	volume of marble	speed of marble	time of drop

11c(ii) — Answer to include:

1 mark	How independent variable can be measured/changed
1 mark	State at least one other variable to be controlled