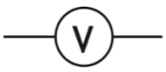
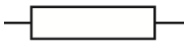
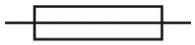
Past Papers
Nat 5
Physics
2014
Marking Scheme

Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	68+	24.9%
B	57+	23.2%
C	47+	20.4%
D	42+	8.9%
No award	<42	22.6%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	11.3 /20	32.4 /60	11.4 /20

2014 Nat5 Physics Marking Scheme

Question	Answer	Physics Covered
1	D	Voltage is a measure of the energy given to charge carriers in a circuit.
2	D	 Lamp |  Voltmeter |  Resistor |  Fuse
3	B	☒A Would only work if R_1 and R_2 have same resistance. This is not stated in question. ☑B The readings of current on A_1 and A_2 are equal if the ammeters are accurate ☒C This set up would short circuit the cell and little current would flow through A_2 ☒D Only some of the current in A_1 would flow through A_2 but could not assess the accuracy of the reading in A_2 without a current reading in the other branch. ☒E This set up would short circuit the cell and little current would flow through A_2
4	C	**Gravitational Potential Energy at 0.25m** E_p = ? m=0.50kg g= 9.8. N kg^{-1} h=0.25m E_p = m g h E_p = 0.50 x 9.8 x 0.25 E_p = 1.2 J **Kinetic Energy at 0.25m** Kinetic energy at 0.25m is gained from conversion of potential energy from 1.00m to 0.25m. E_p = m g h E_p = 0.50 x 9.8 x 0.75 E_p = 3.7 J
5	B	p_1 = 6.0x10^5 Pa V_1 = 2.5 m^3 T_1 = 27°C = 300 K p_2 = ? V_2 = 5.0 m^3 T_2 = 54°C = 327 K $\frac{p_1 \ V_1}{T_1}$ = constant = $\frac{6.0\text{x}10^5 \text{ x } 2.5}{300}$ = 5000 $\frac{P_2 \ V_2}{T_2}$ = constant = $\frac{P_2 \text{ x } 5.0}{327}$ = 5000 $p_2 = \frac{5000 \text{ x } 327}{5.0}$ p_2 = 3.3x10^5 Pa
6	A	☑A Volume-Time graph is a straight line going through the origin. ☒B At absolute zero temperature in Kelvin, the volume is zero (line should go through origin) ☒C This graph does not show an increase in temperature gives an increase in pressure ☒D The Volume-Time graph is a straight line relationship not a curve ☒E This graph does not show an increase in temperature gives an increase in pressure
7	A	Temperature Change in degrees Celsius = 50°C – 17°C = 33°C ∴ Temperature Change in Kelvin = 33K
8	C	Period T = 8ms = 0.008s $T = \frac{1}{f}$ ∴ $0.08 = \frac{1}{f}$ ∴ $f = \frac{1}{0.008s} = 125\text{Hz}$
9	B	All forms of electromagnetic radiation have a speed of 3x10^8 m s^{-1} EM Type: Gamma | X-Ray | Ultra-violet | Visible | Infra-Red | Microwave | Radio & TV **Energy**: High ⟷ Low **Frequency**: High ⟷ Low **Wavelength**: Low ⟷ High
10	B	Radiation Type: Alpha | Beta | Gamma Description: Helium Nucleus | Electron from the nucleus | Electromagnetic Radiation

11 — **E**

Statement I - Correct	Statement II - Incorrect	Statement III - Correct
A lead screen will reduce all types of radiation reaching the sample and reduces the equivalent dose.	The equivalent dose is reduced the further away the sample is from the source of radiation	The longer the time the sample is exposed to radiation, the higher the equivalent dose will be.

12 — **A**

$$A = \frac{N}{t} = \frac{1.44\text{x}10^{8}}{2\text{x}60\text{x}60} = 20000 \text{ Bq} = 2\text{x}10^{4} \text{ Bq}$$

13 — **E**

Statement I - Incorrect	Statement II - Correct	Statement III - Correct
Neutrons are used to bombard a uranium nucleus in nuclear fission	Nuclear fission reactions release heat energy	The neutrons which emerge from a nuclear fission reaction can then go on to cause other nuclei to split in a chain reaction

14 — **A**

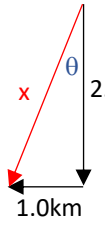
Vector Quantity	force	velocity	**displacement**	**acceleration**	weight
Scalar Quantity	energy	speed	distance	time	**mass**

15 — **E**

Distance Travelled = 2.4km + 1.0 km
= 3.4km

Average speed = 3.4 km in 1 hour
= 3.4 km h^{-1}

Displacement = 2.6 km at 203



$$x = \sqrt{(2.4)^2 + (1.0)^2}$$
$$x = \sqrt{5.76 + 1}$$
$$x = \sqrt{6.76}$$
$$x = 2.6 \text{ km}$$

$$\tan\theta = \frac{\text{opp}}{\text{adj}} = \frac{1.0}{2.4} = 0.417 \quad \therefore \ \theta = 23^{o}$$

$\therefore$ bearing = $180^{o} + 23^{o} = 203$

Average velocity = 2.6 km at 203 in 1 h
= 2.6 km h^{-1} at 203

16 — **D**

E_w = ? F = 10 N d = 3 m

E_w = F d

E_w = 10 x 3

E_w = 30 J

17 — **D**

☒A thicker the elastic the greater the force exerted on ball $\therefore$ 5mm exerts less force than 15mm
☒B thicker the elastic the greater the force exerted on ball $\therefore$ 10mm exerts less force than 15mm
☒C thicker the elastic the greater the force exerted on ball $\therefore$ 10mm exerts less force than 15mm
☑D the thickest elastic (15mm). and the. lowest mass of ball (0.01kg) gives greatest acceleration
☒E the greater the mass of the ball the less the acceleration of the ball due to: $a = {}^{F}/_{m}$

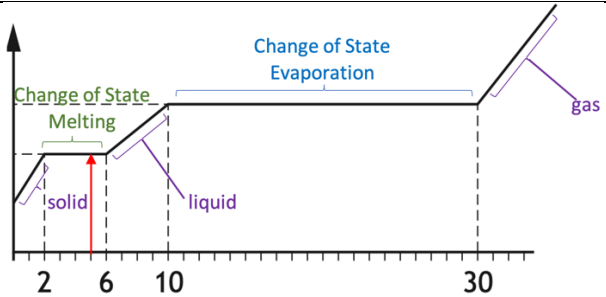
18 — **E**

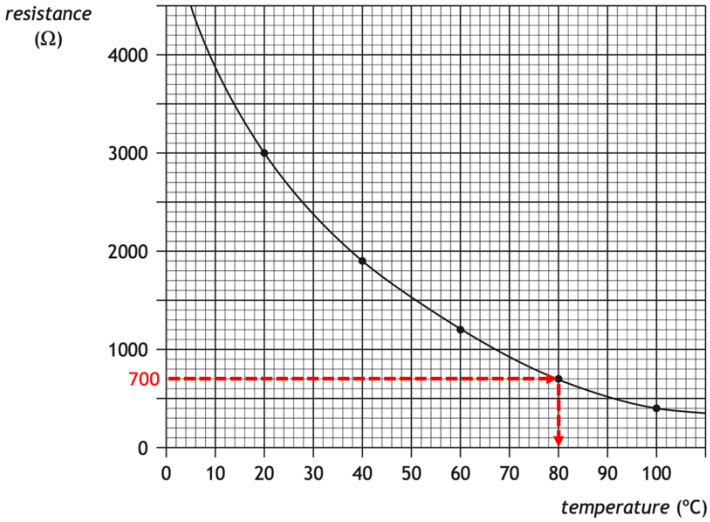
☒A Gravitational field strength being constant would lead to acceleration if only force acting
☒B forces acting are the current forces not previous forces when in space
☒C if air resistance was greater than weight then spacecraft would decrease in speed
☒D if weight was greater than air resistance then spacecraft would increase in speed
☑E balanced forces of weight and air resistance result in constant speed

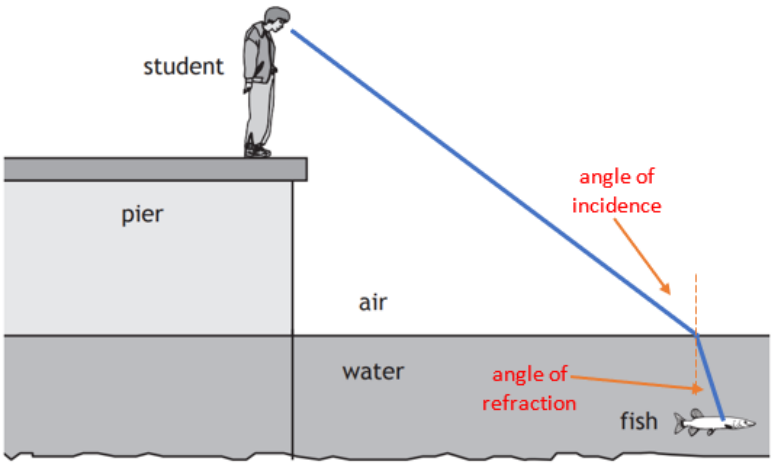
19 — **C**

☒A Ball leaves point R with greater horizontal velocity so will travel further than 2 meters
☒B As ball drops from same height at point R to the ground then time to land is still 1 second.
☑C Time to hit the ground is the same (1s) and distance travels is further than 2m
☒D As ball drops from same height at point R to the ground then time to land is still 1 second.
☒E As ball drops from same height at point R to the ground then time to land is still 1 second.

20 — **D**



<table>
<tr><th>Question</th><th>Answer</th><th>Physics Covered</th></tr>
<tr><td>1a</td><td>1.44 W</td><td>$P = \frac{V^2}{R} = \frac{(12.0)^2}{100} = \frac{144}{100} = 1.44\ W$
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>1b(i)</td><td>20 Ω</td><td>$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ (1 mark)
$\frac{1}{R_T} = \frac{1}{100} + \frac{1}{50} + \frac{1}{50}$ (1 mark)
$\frac{1}{R_T} = \frac{1}{20}$
$R_T = 20\ \Omega$ (1 mark)</td></tr>
<tr><td>1b(ii)</td><td>One answer from each row</td><td>
<table>
<tr><td>1 mark for Effect</td><td colspan="5">The other lamp:</td></tr>
<tr><td></td><td>remains lit</td><td>stays on</td><td>is the same brightness</td><td>gets brighter</td><td>is not affected</td></tr>
<tr><td>1 mark for Justification</td><td>The current still has a path through the other lamp.</td><td>The lamps are connected in parallel</td><td>The current in the other lamp is the same (only acceptable if other lamp stays same brightness)</td><td>The current in the other lamp is greater (only acceptable if other lamp gets brighter)</td><td>It has the same voltage or 12 V (across it)</td></tr>
</table>
</td></tr>
<tr><td>2a(i)</td><td>700 Ω</td><td>$V_2 = V_s - V_1 = 5.0V - 2.0V = 3.0V$ (1 mark)
$I = \frac{V_2}{R} = \frac{3.0}{1050} = 2.857\times10^{-3}\ A$
$R_1 = \frac{V_1}{I} = \frac{2.0}{2.857\times10^{-3}} = 700\ \Omega$
1 mark for Ohm's Law equation 1 mark for substitutions 1 mark for final answer including units</td></tr>
<tr><td>2a(ii)</td><td>80 °C</td><td> 
</td></tr>
<tr><td>2b(i)</td><td>Answer to Include:</td><td>
<table>
<tr><td>1 mark</td><td>(as R_{th} increases) V_{th} increases</td></tr>
<tr><td>1 mark</td><td>When { V_{th} = 2·0 V / V reaches switching voltage } { MOSFET / transistor } turns on</td></tr>
<tr><td>1 mark</td><td>Relay switches on (the heater)</td></tr>
</table>
</td></tr>
<tr><td>2b(ii)</td><td>Answer to Include:</td><td>
<table>
<tr><td>1 mark</td><td>Temperature decreases</td></tr>
<tr><td>1 mark</td><td>Resistance of thermistor must { be greater / increase }</td></tr>
<tr><td>1 mark</td><td>to switch on { MOSFET / transistor }</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td>3a</td><td>Working showing
9000 J</td><td>E = ? P = 15 W t = 10 minutes = 10x60 s
E = P x t (1 mark)
E = 15 x 10x60 (1 mark)
E = 9000 J</td></tr>
<tr><td>3b(i)</td><td>X</td><td>Different materials require different quantities of heat to raise the temperature by the same temperature.
If the same quantity of heat energy is supplied to each block
• Block with greatest specific heat capacity will increase in temperature slowest (X)
• Block with lowest specific heat capacity will increase in temperature fastest (Y)</td></tr>
<tr><td>3b(ii)</td><td>900 J kg^{-1} ^{o}C^{-1}</td><td>E = 9000J c = ? m = 1.0 kg ΔT= 25^{o}C – 15^{o}C = 10^{o}C
E = c x m x ΔT (1 mark)
9000 = c x 1.0 x 10 (1 mark)
c = 900 J kg^{-1} ^{o}C^{-1} (1 mark)</td></tr>
<tr><td>3c(i)</td><td>One answer from:</td><td>Insulating the (metal) block <u>or</u> Switch heater on for shorter time</td></tr>
<tr><td>3c(ii)</td><td>One answer from:</td><td><table><tr><td>If previous answer was For Insulating</td><td>If previous answer was For Shorter Time</td></tr><tr><td>Increase or Greater</td><td>Decrease or Lower</td></tr></table></td></tr>
<tr><td>4a</td><td>2.4 m s^{-1}</td><td>f = ? No. of Waves N = 4 time t = 20s
$f = \frac{N}{t} = \frac{4}{20}$ = 0.2 Hz (1 mark)
f = 0.2Hz λ = 12m v = ?
v = f x λ (1 mark)
= 0.2 x 12 (1 mark)
= 2.4 m s^{-1} (1 mark)</td></tr>
<tr><td>4b</td><td>Diagram showing:</td><td> 

<table><tr><td>1 mark</td><td>mark for ray changing direction at water/air boundary</td></tr><tr><td>1 mark</td><td>angle of incidence in water less than the angle of refraction in air</td></tr></table></td></tr>
<tr><td>5a</td><td>4</td><td>Total Effect of UV radiation = 280
Elevation above sea level = 2km ∴ Elevation above sea level adjustment = 1.12
Cloud Cover = overcast ∴ cloud adjustment = 0.31
$\text{UV Index} = \frac{[\text{Total Effect of UV radiation} \times \text{Elevation above sea level adjustment} \times \text{Cloud adjustment}]}{25}$
$\text{UV Index} = \frac{[280 \times 1.12 \times 0.31]}{25}$
UV Index = 3.89 = 4</td></tr>
</table>

5b

P	(Q)	**R**
(R)	**R**	**P**

Problem Solving Question processing information from multiple lines on a line graph

5c

One answer from:

Detecting counterfeit bank notes	Setting dental fillings	Any other sensible answer.

6a

The time taken for the activity of a radioactive source to half.

The time taken for the [activity / corrected count rate] (of a radioactive source) to half.

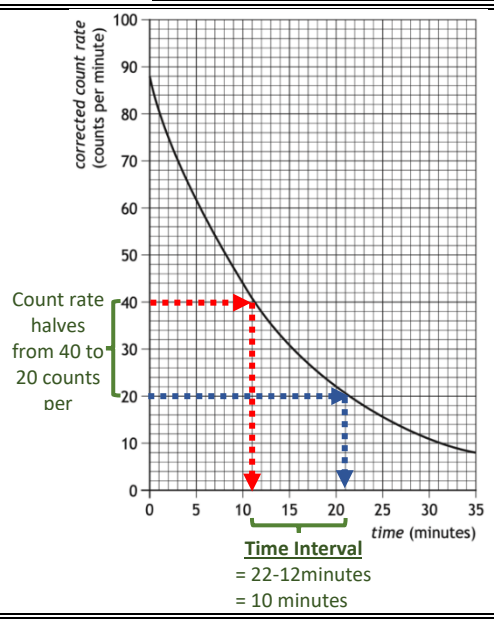
6b(i)

Answer to include:

1 mark	Measure the count in a set time interval
1 mark	Repeat at (regular) intervals
1 mark	Measure background (count) and subtract

6b(ii)

10 minutes



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

Work out the time interval on the x-axis for this halving.

6b(iii)

5.5 counts per minute

Halving of corrected count rate (1 mark)

88 → 44 → 22 → 11 → 5.5 (1 mark)

Counts per minute

7

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.

8a(i)

9.0×10^{-5} Gy

D = ? $E = 7.2mJ = 7.2 \times 10^{-3} J$ m = 80.0kg

$D = \frac{E}{m}$ (1 mark)

$D = \frac{7.2 \times 10^{-3}}{80.0}$ (1 mark)

$D = 9.0 \times 10^{-5}$ Gy (1 mark)

8a(ii)

9.0×10^{-5} Sv

H = ? $D = 9.0 \times 10^{-5}$ Gy $w_R = 1$

$H = D \times w_R$ (1 mark)

$H = 9.0 \times 10^{-5} \times 1$ (1 mark)

$H = 9.0 \times 10^{-5}$ Sv (1 mark)

8b

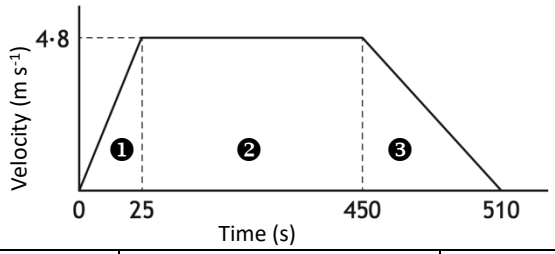
One answer from:

When an atom [gains / loses / gains or loses] electrons

9

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.

<table>
<tr><td>10a(i)</td><td>0.19 m s^{-2}</td><td>a = ? $v = 4.8$ m s^{-1} $u = 0$ m s^{-1} $t = 25$ s
$a = \frac{v - u}{t} = \frac{4.8 - 0}{25} = 0.19$ m s^{-2}
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>10a(ii)</td><td>constant speed or constant velocity</td><td>The boat has a constant velocity as the line between 25 s and 450 s is horizontal. The boat is neither speeding up or slowing down. Constant velocity would also be constant speed with only magnitude of velocity taken into account.</td></tr>
<tr><td>10a(iii)</td><td>One diagram from:</td><td>forward force ← Boat → friction or friction ← Boat → forward force</td></tr>
<tr><td>10b(i)</td><td>2244 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 25 x 4.8</td><td>= 4.8 x 425</td><td>= ½ x 60 x 4.8</td></tr>
<tr><td>= 60</td><td>= 2040</td><td>= 144</td></tr>
<tr><td colspan="3">Total distance = 60 + 2040 + 144 = 2244m</td></tr>
</table></td></tr>
<tr><td>10b(ii)</td><td>4.4 m s^{-1}</td><td>$v = \frac{\text{total distance}}{\text{time}} = \frac{2244}{510} = 4.4$ m s^{-1}
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>11a</td><td>To check that the maximum take-off weight is not exceeded.</td><td>Maximum weight of passengers = maximum take-off weight – weight of empty helicopter
= 24000 N – 13500 N
= 10500 N
10500 N is approximately 1071 kg so total mass of passengers must not exceed 1071 kg</td></tr>
<tr><td>11b</td><td>19625 N</td><td>Minimum upward force required at takeoff = weight of helicopter + weight of passengers
= 13500 N + 6125 N
= 19625 N</td></tr>
<tr><td>11c</td><td>3000 s</td><td>d = 201 km = 201000 m cruising speed $v = 67$ m s^{-1} t = ?
d = v t (1 mark)
201000 = 67 x t (1 mark)
d = 3000 s (1 mark)</td></tr>
<tr><td>12a</td><td>9.2 N</td><td>W = ? m = 0.94kg g = 9.8 N kg^{-1}
W = m g (1 mark)
W = 0.94 x 9.8 (1 mark)
W = 9.2 N (1 mark)</td></tr>
<tr><td>12b</td><td>1.5x10^{-4} Pa</td><td>Total Area of three fins A = 3 x 2.0x10^{-4} m^2 = 6.0x10^{-4} m^2 (1 mark)
$P = \frac{F}{A} = \frac{9.2}{6.0\text{x}10^{-4}} = 1.5\text{x}10^{-4}$ Pa
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>12c</td><td>One answer from:</td><td>rocket / bottle pushes down on water, water pushes up on rocket / bottle</td></tr>
<tr><td>12d</td><td>380 m s^{-2}</td><td>F_{un} = upthrust – weight = 370 – 9.2 = 360.8 N (1 mark)
a = ? F = 360.8 N m = 0.94 kg
$a = \frac{F}{m} = \frac{360.8}{0.94} = 380$ m s^{-2}
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>12e</td><td>Two answers from:</td><td>more water will increase weight/mass | unbalanced force decreases | acceleration is less</td></tr>
</table>