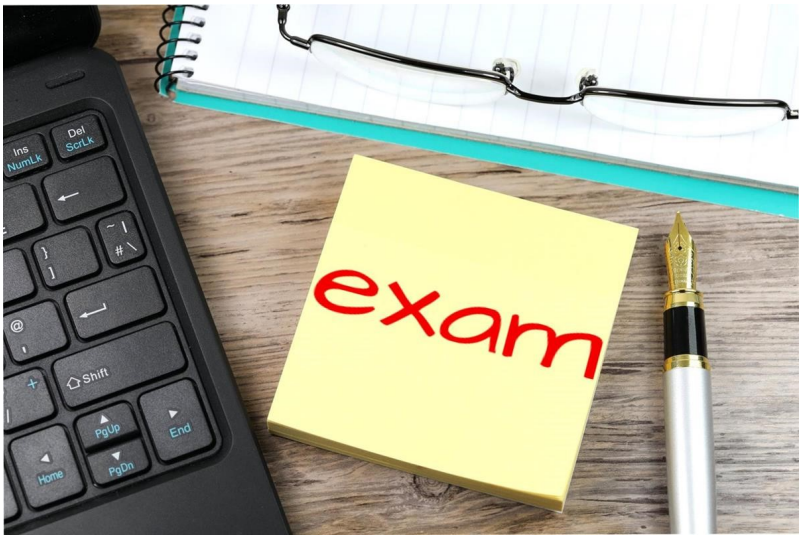
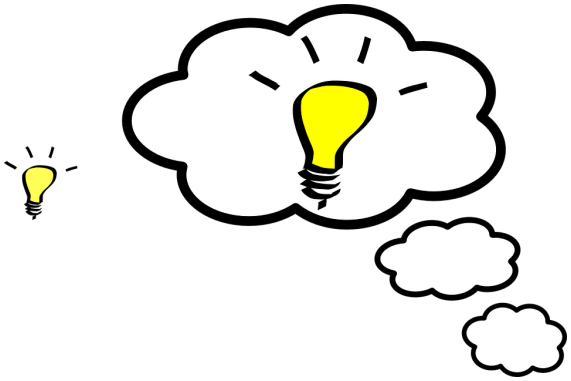


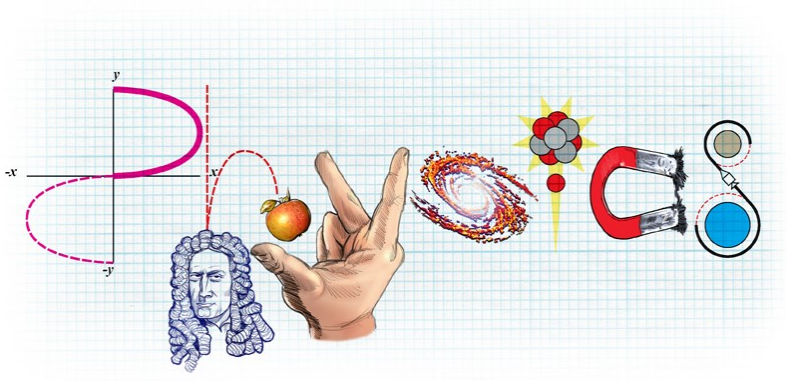


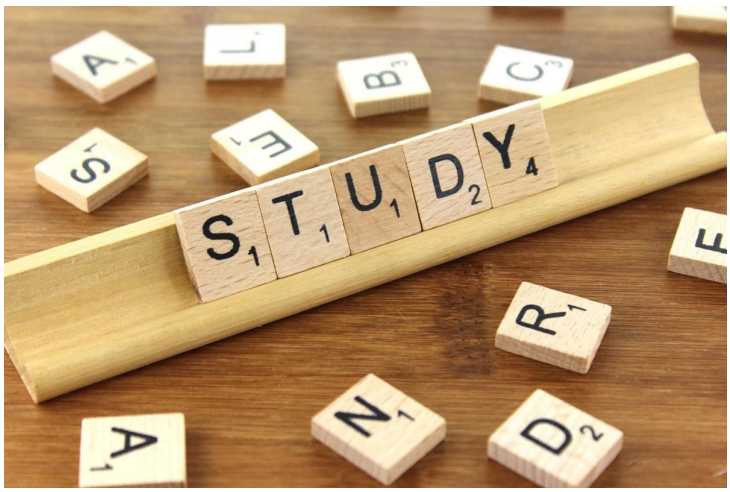
National 5 Physics

Immersion Day

Challenging past paper questions

Marking Scheme





1.

(a)	(i)	As the distance increases the infrared radiation detected decreases	1	Accept: As the distance decreases the infrared radiation detected increases Do not accept: Conclusions that only relate to the relationship between distance and voltage.
	(ii)	Similar shape to original curve (1) Line always below original curve (1)	2	Curve does not need to cover entire range of original curve. Curve can extend beyond the range of the original curve

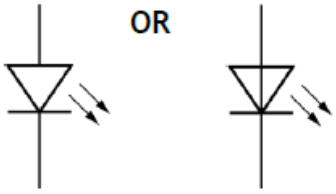
(b)		**Award 3 marks** where the candidate has demonstrated a good understanding of the physics involved. They show a good comprehension of the physics of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, 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. **Award 2 marks** where the 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. **Award 1 mark** where the 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. **Award 0 marks** where the candidate has not demonstrated an understanding of the physics involved. There is no evidence that they have recognised the area of physics involved, or they have not given any statement of a relevant physics principle. Award this mark also if the candidate merely restates the physics given in the question.	3	Candidates may use a variety of physics arguments to answer this question. Award marks based on candidates demonstrating overall good, reasonable, limited, or no understanding

2.

(a)	(i)	suitable scales, labels and units (1) all points plotted accurately to ± half a division (1) best fit curve (1)	3	A non-linear scale on either axis prevents access to any marks (0). Allow broken axes from origin (with or without symbol)
	(ii)	(Resistance of wire) increases (as the length of wire increases) (1) Current decreases (as the length of wire increases). (1)	2	Effect must be correct, otherwise (0) marks. Can be justified by suitable calculations involving currents from the table/graph.
	(iii)	0·55 A	1	Must be consistent with candidate's curve or line. Unit required If a candidate has not shown a curve or line in (a)(i) this mark cannot be accessed. If candidate has used a non-linear scale in (a)(i) this mark cannot be accessed.
	(iv)	repeat (and average)	1	Accept: • increase the range of lengths • increase the number of different lengths If candidates use the terms 'accurate' and/or 'precise' in their response, they must be used correctly otherwise (0).
(b)		(Resistance will be) less (than 5·2 Ω) (1) (The wire now has) shorter length (between X and Y) OR (Two wires are) connected in parallel (1)	2	First mark can only be awarded if a justification is attempted. Effect correct + justification correct (2) Effect correct + justification incomplete (1) Effect correct + justification incorrect (wrong physics) (0) Effect correct + no justification attempted (0) Incorrect or no effect stated regardless of justification (0) If candidate tries to justify this by calculation, then the substitution must be correct (R_1 and R_2 are both equal to 2·6 Ω) or (0) marks.

Further info relating to question 2b:

This was intended to be a challenging question and few candidates realised that the resistance would be less than 5·2 Ω. Successful candidates were able to explain that folding the wire and connecting the ohmmeter as shown would mean that there were two sections of wire of shorter length in parallel, both aspects of which would reduce the resistance.

3. (a)		3 A	1	
(b)		$P = \frac{V^2}{R}$ (1) $0.35 \times 10^3 = \frac{230^2}{R}$ (1) $R = 150\ \Omega$ (1)	3	Accept: 200 151 151.1 For alternative methods: (1) for all required relationships (1) for all substitutions (1) for final answer including unit
(c)	(i)	 OR	1	Must have correct orientation.
	(ii)	Voltage across variable resistor increases (1) Transistor switches on (1)	2	Do not accept 'voltage through the variable resistor' Ignore any stated values of switching voltage.
	(iii)	To adjust/control the moisture level at which the dehumidifier/transistor LED/fan switches on.	1	To adjust/control when the dehumidifier/transistor/LED/fan switches on.

Further info relating to question 3:

(a) Only some candidates stated an appropriate fuse rating for the dehumidifier given its power rating. Candidates are expected to be able to select whether a 3 A or 13 A fuse should be used for an appliance, based on its power rating.

(b) Many candidates were able to calculate the resistance of the dehumidifier. However, a few candidates used their chosen fuse rating as the current, which is not appropriate.

(c)(i) Few candidates drew the correct symbol for an LED.

(c)(ii) Few candidates explained how the circuit shown operates to turn on the LED when the moisture in the air increases above a certain level. Many candidates did not state that the voltage across the variable resistor would increase, and many candidates did not indicate that the transistor would switch on.

(c)(iii) Few candidates explained the purpose of the variable resistor, in terms of it allowing adjustment to the moisture level at which the circuit operates.

4.

(a)		For $\frac{p}{T}$: $\left(\frac{121\times10^3}{323}\right) = 375$ $\left(\frac{124\times10^3}{333}\right) = 372$ $\left(\frac{128\times10^3}{343}\right) = 373$ $\left(\frac{132\times10^3}{353}\right) = 374$ (2) For $\frac{T}{p}$: $\left(\frac{323}{121\times10^3}\right) = 0.00267$ $\left(\frac{333}{124\times10^3}\right) = 0.00269$ $\left(\frac{343}{128\times10^3}\right) = 0.00268$ $\left(\frac{353}{132\times10^3}\right) = 0.00267$ Statement of relationship: $\frac{p}{T} = constant$ OR $\frac{T}{p} = constant$ OR $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ OR p is (directly) proportional to T (in kelvin) (1)	3	If only 1 or 0 sets of data used (0) for entire question **Calculations:** First two marks are awarded for the calculations: • All four calculations correct (2) • Three calculations correct (1) • Fewer than three calculations correct (0) Accept 2 - 5 sig figs in all calculated values. Conversion from kPa to Pa not required **Relationship:** Mark for $\frac{p}{T} = constant$ can only be accessed if the candidate has completed calculations using a minimum of two sets of data, however the relationship must be supported by all the candidate's calculated values. Do not accept $\frac{pV}{T} = constant$ Do not accept: $\frac{p^1}{T^1} = \frac{p^2}{T^2}$

4.

(continued)			**Alternative method:** If candidate uses $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ to verify values of pressures or temperatures in the table then they must make it clear that the calculated value is approximately the same as the value in the table for any marks to be awarded. Thereafter: All four sets of data linked (minimum of three calculations) (1) All calculations correct (1) Relationship stated and supported (1) **Graphical method:** Must be on graph paper for any marks to be awarded. **(1)** suitable scales, labels and units **(1)** all points plotted accurately to ±half a division and line of best fit **(1)** relationship stated
(b)		Any single value between 138 kPa and 142 kPa inclusive	1	Unit required
(c)		Repeat the experiment **OR** Increase the range (of temperatures) **OR** Take readings at more (different) temperatures within the range **OR** Have more of the flask in the water **OR** Add more water (in the beaker) **OR** Reduce the length/diameter of the connecting tube **OR** Stir the water	1	Accept: Place thermometer inside the flask/in the gas. Apply +/- rule for surplus answers. Candidates do not have to use the terms accurate, precise or reliable, but if they do so they must use them correctly. Accept an appropriate use of insulation (eg 'insulate the connecting tube/top of flask'), but not a generic use of insulation.

4.

(d)		(The increase in temperature) increases the kinetic energy of the gas particles/the particles move faster. (1) The particles hit the tyre walls more frequently OR The particles hit the tyre walls with greater force. (1) Pressure (in the tyre) increases (1)	3	Accept: 'atoms'/'molecules' in place of 'particles' An incorrect statement about collisions does not allow this mark to be awarded eg 'more frequent and less force' or 'less frequent and more force'. Do not accept: 'particles hit the tyre walls more' alone

Further info relating to question 4:

(a) Only a few candidates used all the appropriate data to establish the relationship between the pressure and the temperature of the gas. Many candidates tried to explain the relationship in qualitative terms, rather than carrying out any numerical calculations or drawing a graph.

(b) Many candidates were able to make an appropriate prediction for the pressure.

(c) Only some candidates suggested an appropriate way in which the experiment could be improved. A common incorrect response was to 'insulate the apparatus', without being specific about what part of the apparatus should be insulated in such a way as to improve the experiment.

(d) Most candidates were able to attempt an explanation using the kinetic model, and some candidates went on to give full and accurate explanations.

5.

(a)		(Nuclear fission is when a large) nucleus (of an atom) splits (into two or more smaller nuclei).	1	Do not accept: atom alone
(b)	(i)	$P = \frac{E}{t}$ **(1)** $150 \times 10^6 = \frac{E}{60 \times 60}$ **(1)** $(E = 5.4 \times 10^{11}\ \text{J})$ $\text{number of fissions} = \frac{5.4 \times 10^{11}}{2.9 \times 10^{-11}}$ **(1)** $= 1.9 \times 10^{22}$ **(1)**	4	Accept: 2×10^{22} 1.86×10^{22} 1.862×10^{22} Calculation of power of one decay over an hour is wrong physics, MAX (1) for relationship. **Alternative method 1:** $P = \frac{E}{t}$ **(1)** $150 \times 10^6 = \frac{2.9 \times 10^{-11}}{t}$ **(1)** $(t = 1.93 \times 10^{-19})$ $\text{number of fissions} = \frac{60 \times 60}{1.93 \times 10^{-19}}$ **(1)** $= 1.9 \times 10^{22}$ **(1)** **Alternative method 2:** $\text{fissions per second} = \frac{150 \times 10^6}{2.9 \times 10^{-11}}$ **(1)** $= 5.17 \times 10^{18}$ **(1)** $\text{total fissions} = 5.17 \times 10^{18} \times 60 \times 60$ **(1)** $= 1.9 \times 10^{22}$ **(1)**
	(ii)	Any one of: Requires high temperatures Difficult to control/contain plasma Requires strong magnetic fields	1	Or any other suitable statements relating to difficulties in sustaining reactions. Accept: 'Requires high pressure' 'Difficult to control/contain energy/heat produced' Answers in terms of cost alone are insufficient. Apply +/- rule for surplus answers.

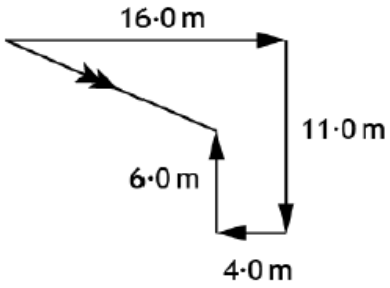
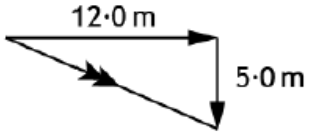
Further info relating to question 5:

(a) Only some candidates stated that nuclear fission involves the splitting of a large nucleus into smaller nuclei. Some candidates incorrectly used the term ‘atom’ instead of ‘nucleus’.

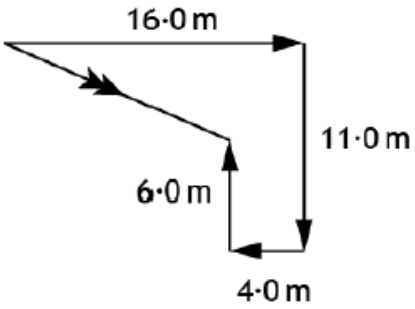
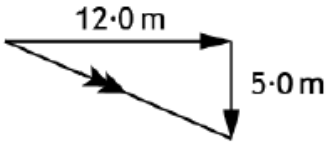
(b)(i) Few candidates were able to determine the minimum number of fission reactions correctly, although many were able to determine the energy produced by the reactor in an hour.

(b)(ii) Many candidates did not describe a difficulty in sustaining nuclear fusion reactions in a reactor. Some described a difficulty in initiating the reaction in the first place, and others described socio-economic issues related to nuclear fusion, neither of which addressed the question asked. A few candidates even stated that nuclear fusion was not possible.

6.

(a)	(i)	Using Pythagoras: Resultant^2=12·0^2+5·0^2 (1) Resultant=13m (1) Using scale diagram:  or  Vectors to scale (1) Resultant=13m (1) (allow ± 0·5 m tolerance)	2	Ignore any direction stated in the final answer in this part. If clear arithmetic error shown in 16 - 4 = 12 or 11 - 6 = 5 then MAX (1) mark for substitution consistent with arithmetic error. No requirement for arrows to be shown on diagram to calculate the magnitude of displacement. Regardless of method, if a candidate shows a vector diagram (or a representation of a vector diagram ie a triangle with no arrows) and the vectors have been added incorrectly, eg head-to-head then MAX (1).

6.

(ii)	Using trigonometry: $\tan\theta = \frac{5{\cdot}0}{12{\cdot}0}$ (1) $(\theta = 23°)$ direction = 113 (1) Using scale diagram:  or  Vectors to scale (1) Direction = 113 (1) (allow ±2° tolerance)	2	Or use of resultant value (and appropriate trigonometry) consistent with (a)(i). Accept: 23° South of East 67° East of South Ignore the degree symbol if the direction is stated as a bearing. Can also do using other trig functions, eg $\sin\theta = \frac{5{\cdot}0}{13}$ or $\cos\theta = \frac{12{\cdot}0}{13}$ Regardless of method, if a candidate shows a vector diagram (or a representation of a vector diagram ie a triangle with no arrows) and the vectors have been added incorrectly, eg head-to-head then MAX (1). Accept: 20° S of E 110 22·6° S of E 112·6 22·62° S of E 112·62
(b)	$s = \bar{v}t$ (1) $13 = \bar{v} \times 32{\cdot}5$ (1) $\bar{v} = 0{\cdot}40\ \text{ms}^{-1}$ at (bearing) 113 (1)	3	Or consistent with (a)(i) and/or (a)(ii) Accept $d = vt$ provided it is followed by a substitution of the value for displacement. Direction required for final mark. Accept 1-4 sig figs: 0·4 m s^{-1} 0·400 m s^{-1} 0·4000 m s^{-1}

6.

(c)		$d = \bar{v}t$ (1) $37{\cdot}0 = 1{\cdot}25 \times t$ (1) $(t = 29{\cdot}6\ \text{s})$ difference in time $= (32{\cdot}5 - 29{\cdot}6)$ $= 2{\cdot}9\text{s}$ (1)	3	Accept $s = \bar{v}t$ provided it is followed by a substitution of the value for distance. Accept 1-4 sig figs: 3 s 2·90 s 2·900 s
(d)		(The forces are) equal (in size) and opposite (in direction).	1	Accept: '(the forces are) balanced' Do not accept 'lift equals weight' alone.

Further info relating to question 6:

(a)(ii) Although most candidates calculated an angle for the resultant of the displacements acting at right-angles, many candidates were unable to express this angle as a bearing or compass direction.

(b) Many candidates calculated the average speed of the quadcopter, rather than its average velocity. Also, few candidates included a direction associated with the velocity, as is required when stating the value of a vector quantity.

(d) Many candidates failed to identify that this situation involved balanced forces. Many simply stated that the forces acting on the quadcopter were equal without qualifying this by reference to their relative directions.

7.	(a)		$P=\frac{E}{t}$ (1) $3500=\frac{E}{26}$ (1) $E=91000\ \text{J}$	2	** SHOW THAT ** Must start with a correct relationship or (0) marks Final answer of 91 000 J or its numerical equivalent, including unit, must be shown, otherwise a maximum of (1) can be awarded.
	(b)	(i)	$E_h=cm\Delta T$ (1) $=4180\times0\times250\times80\times0$ (1) $=83\,600\ \text{J}$ (1)	3	Accept 2-5 sig figs: 84 000 J
		(ii)	$E_h=91000-83\,600$ (1) $(=7400\ \text{J})$ $E_h=ml$ (1) $7400=m\times22\times6\times10^5$ (1) $m=0\times0033\ \text{kg}$ (1)	4	Or consistent with (b)(i) Calculation of energy difference may be implied by correct substitution. If no attempt to calculate the energy difference, or incorrect substitution to calculate energy difference, then MAX (1) for relationship. If clear arithmetic error is shown in calculation of energy difference then MAX (3). accept: 1-4 sig figs: 0·003 kg 0·003 27 kg 0·003 274 kg
		(iii)	Heat (energy) lost to the surroundings. OR Some of the heat (energy) is used to heat the dispenser.	1	Accept: not all the heat (energy) is transferred into the water. Do not accept: 'heat loss' alone - it must be clear where it is going.

Further info relating to question 7:

(b)(ii) Although most candidates realised that this question required a calculation involving latent heat of vaporisation, few were able to determine the energy that was available to vaporise the water before carrying out the calculation. Many candidates mistakenly used the energy value calculated in the previous part of the question, which was the energy required to raise the temperature of the water to its boiling point.

(b)(iii) Few candidates were able to explain that the mass of steam produced would be less because of heat loss to the surroundings. Many simply stated that heat would be lost, rather than explaining where it would go to.

8.

(a)	(i)	All four substitutions for $\frac{p}{T}$ OR $\frac{T}{p}$ (1) All values calculated correctly (1) For $\frac{p}{T}$: $\frac{101\times10^3}{293} = 345$ $\frac{107\times10^3}{313} = 342$ $\frac{116\times10^3}{333} = 348$ $\frac{122\times10^3}{353} = 346$ For $\frac{T}{p}$: $\frac{293}{101\times10^3} = 0{\cdot}00290$ $\frac{313}{107\times10^3} = 0{\cdot}00293$ $\frac{333}{116\times10^3} = 0{\cdot}00287$ $\frac{353}{122\times10^3} = 0{\cdot}00289$ Statement of: $\frac{p}{T} = constant$ OR $\frac{T}{p} = constant$ OR $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ OR p is (directly) proportional to T (in kelvin) (1)	3	If only 1 or 0 sets of data used (0) for entire question Substitutions may be implied by all four calculated values. For the second mark, values must be calculated correctly for all substitutions shown by the candidate (minimum of using at least two sets of data). Accept 2-5 sig figs in all calculated values. Conversion from kPa to Pa not required. Mark for $\frac{p}{T} = \text{constant}$ can only be accessed if the candidate has completed calculations using a minimum of two sets of data, however the relationship must be supported by all the candidate's calculated values. Do not accept $\frac{pV}{T} = constant$ **Graphical method:** Must be on graph paper for any marks to be awarded suitable scales, labels and units (1) all points plotted accurately to ±half a division and line of best fit (1) relationship stated (1)

8.

				Alternative method: If candidate uses $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ to verify values of pressures or temperatures in the table then they must make it clear that the calculated value is approximately the same as the value in the table for any marks to be awarded. Thereafter: All four sets of data linked (minimum of three calculations) (1) All calculations correct (1) Relationship stated and supported (1)
(a)	(ii)	(The increase in temperature) increases the kinetic energy of the gas particles/the particles move faster. (1) The particles hit the container/walls more frequently. (1) The particles hit the container/walls with greater force. (1)	3	Independent marks Accept: 'atoms'/'molecules' in place of 'particles' Do not accept: 'particles hit the container/walls more' alone
	(iii)	Any single value between 83 kPa and 89 kPa inclusive	1	Unit must be stated Excessive sig figs should be ignored.
(b)		Have more of the flask under the water, (1) so that the gas is at the same temperature/evenly heated (1) OR Reduce the length/diameter/volume of the connecting tube (1) so that the gas is at the same temperature/evenly heated (1)	2	Accept: Place the temperature sensor in the flask (1) So that the temperature of the gas is being measured (1) Accept: 'so that all the gas is being heated' Do not accept: 'repeat measurements' - it is an improvement to the set up that is required

Further info relating to question 8:

(a)(i): Only some candidates seemed familiar with the principle of how to establish a relationship using experimental data. Many candidates attempted to apply Boyle's law using one set of data to calculate one of the values in another set of data, without recognising the discrepancy between the value calculated and the experimental value obtained.

For candidates who correctly attempted to calculate the ratio between the temperature and pressure of the gas, there were often instances of incorrect rounding and significant figure issues in the values calculated.

Some candidates did attempt to establish the relationship graphically, but as they only produced a sketch graph of the data (rather than an accurate graph, using graph paper), no marks were awarded.

(a)(ii): Few candidates provided a complete explanation of why the pressure in a gas increases as its temperature increases, using the kinetic model. Many identified the speed of the gas particles increases as the temperature increases. Only some were able to describe how this affected the frequency of the collisions of the particles on the walls of the container and fewer still, how this affected the force of the individual collisions of the particles on the walls, as opposed to the overall force.

b): Few candidates were able to state a way in which the experimental set-up could be improved. Many simply identified a procedural change that they thought would improve the experiment.

9.

(a)		Any one of: • photodiode • phototransistor • thermistor • LDR • thermocouple • thermopile • CCD.	1	Do not accept: • skin • (infrared) camera • (thermal imaging) camera • photographic film • thermogram • (black bulb) thermometer • thermochromic film. Apply +/- rule for surplus answers.
(b)		$N = 54$ (1) $f = \frac{N}{t}$ (1) $f = \frac{54}{60}$ (1) $f = 0{\cdot}90$ Hz	3	**'Show' question** Must state the correct relationship or MAX (1) for identifying $N = 54$. Final answer of 0·90 Hz or 0·9 Hz, including unit, must be shown, otherwise MAX (2). **Alternative method:** Marks can only be awarded for this method if substitution for calculation of the period is shown. $T = \frac{60}{54} (= 1{\cdot}11)$ (1) $f = \frac{1}{T}$ (1) $f = \frac{1}{1{\cdot}11}$ (1) $f = 0{\cdot}90$ Hz For alternative methods calculating N or t, there must be a final statement to show the calculated value of N or t is the same as the value stated in the question.
(c)	(i) (A)	Normal drawn and labelled	1	Must be 'passably' perpendicular and straight and must appear in both materials. Does not need to be dashed Accept: 'N', 'n' or 'A' as label

9. (c)	(i) (B)	Both angles indicated and labelled	1	Accept: i and r I and R θ_i and θ_r If normal has been incorrectly drawn, then this mark is still accessible, provided angles are indicated to the normal within each material and labelled.
	(ii)	(Wavelength in water is) greater (than in glass). (1) Speed of light (in water) is greater (than in glass). (1)	2	First mark can only be awarded if justification is attempted Effect correct + justification correct (2) Effect correct + justification incomplete (1) Effect correct + justification incorrect (wrong physics) (0) Effect correct + no justification attempted (0) Incorrect or no effect stated regardless of justification (0) Accept: 'refractive index in water is less than glass' 'water is less optically dense than glass' for justification The effect can be justified by appropriate calculations.

Further info relating to question 9:

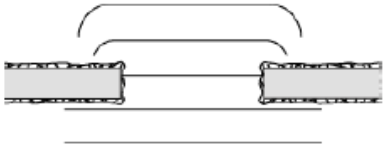
(a): Few candidates were able to state a suitable detector of infrared radiation for the rain sensor.

(b): This is a 'show' type question and many candidates did not show all the required stages of the calculation to access all the marks. These stages include starting with a correct formula, showing the correct substitutions and ending with the correct final value, including the unit. In particular, many candidates did not make reference to the relationship between frequency, number and time in their response. This meant they were unable to access marks beyond those for selecting the correct number of times the windscreen wipers move back and forth in a minute.

(c)(i)(A): Few candidates were able to draw and label a suitable normal on the diagram provided. Many candidates drew lines representing the normal that were not perpendicular to the interface between the mediums.

(c)(i)(B): This is a 'must justify' question and although a number of candidates stated a correct response, they either did not provide any supporting justification, or provided an incorrect justification (for example that the frequency of the infrared light changes as it travels between mediums) and were therefore unable to access any marks.

10.

(a)	(i)	$T = \frac{1}{f}$ (1) $2 \cdot 5 = \frac{1}{f}$ (1) $f = 0 \cdot 40$ Hz (1)	3	Accept: $f = \frac{N}{t}$ Accept 1-4 sig fig: 0·4 Hz 0·400 Hz 0·4000 Hz
	(ii)	measure the time for more waves to pass OR count the number of waves in a longer period of time OR repeat (the measurement) and average	1	Do not accept answers relating to precision eg a stopclock with more decimal places.
(b)		$v = f\lambda$ (1) $v = 0 \cdot 40 \times 8 \cdot 0$ (1) $v = 3 \cdot 2$ m s^{-1} (1)	3	Or consistent with (a)(i) Accept 1-4 sig fig: 3 m s^{-1} 3·20 ms^{-1} 3·200 ms^{-1} **Method 2:** $d = vt$ (1) $8 \cdot 0 = v \times 2 \cdot 5$ (1) $v = 3 \cdot 2$ m s^{-1} (1)
(c)		diffraction of waves into 'shadow' regions behind walls (1) straight sections in middle and consistent wavelengths before and after gap (1) 	2	
(d)		energy decreases/lost	1	Accept: description of energy being spread over greater area.

Further info relating to question 10:

(a)(ii): Many candidates did not make a suitable suggestion about how the accuracy of the frequency determined for a wave could be improved. Some candidates simply stated that measurements should be repeated, without indicating that the average of these measurements should be determined.

(c): Although many candidates correctly represented diffraction taking place as waves passed between two obstacles, few were able to complete the diagram accurately indicating that the section of waves passing through the middle of the gap would continue to travel in the same direction, without any change in wavelength (ie there would be some straight sections).

(d): Few candidates explained that a decrease in amplitude of the waves related to a decrease in energy.

11.	(a)		80 000 (nuclei) decay(s) per unit time	1	Accept: 'per second' in place of 'per unit time'
	(b)	(i)	neutrons can go on to cause further (fission) reactions/split more (uranium) nuclei (1) causing a chain reaction/this process repeats (1)	2	Independent marks.
		(ii)	$(E) = 3 \cdot 0 \times 10^{21} \times 3 \cdot 2 \times 10^{-11}$ (1) $= (9 \cdot 6 \times 10^{10}\ \text{J})$ $P = \frac{E}{t}$ (1) $= \frac{9 \cdot 6 \times 10^{10}}{60}$ (1) $= 1 \cdot 6 \times 10^{9}\ \text{W}$ (1)	4	**Method 2:** $A = \frac{N}{t}$ (1) $= \frac{3 \cdot 0 \times 10^{21}}{60}$ (1) $= (5 \times 10^{19}\ \text{Bq})$ $P = 5 \times 10^{19} \times 3 \cdot 2 \times 10^{-11}$ (1) $= 1 \cdot 6 \times 10^{9}\ \text{W}$ (1) Calculation of power of one decay over a minute then multiplication by number of decays per minute is wrong physics MAX (1) for relationship
	(c)		any suitable use (eg treating cancer/tracers/ sterilisation/smoke detectors/ measuring thickness of paper)	1	Must be a use of nuclear radiation

Further info relating to question 11:

(a): Few candidates were able to state what is meant by the activity of a radioactive source when related to a specific value. Many candidates simply stated that activity was the number of decays per second without reference to the value of 80 kBq stated in the stem of the question.

(b)(i): Some candidates did not make it clear that it was the neutrons released in one reaction that went on to cause further reactions. A few candidates indicated that they appeared to think that it was a single nucleus that kept splitting rather than a succession of different nuclei.

(b)(ii): Some candidates obtained a correct final answer by an incorrect principle of physics; namely that the energy released in a single nuclear reaction could be 'spread out' over a prolonged period of time. These candidates were unable to access any marks other than that allocated for the relationship between power, energy and time.

(c): Only a minority of candidates were able to state a suitable use of nuclear radiation. Responses relating to generation of electrical energy were not acceptable as this had already been stated in the stem of the question.