1	(a) $v = u + at$	no, but if u is zero then v is proportional to t	1	
		provided a is constant	1	2
	$pV = nRT$	not unless T is in kelvin	1	
		and both n and V are constant (R is a constant)	1	2
	$P = Fv$	yes if v is constant	1	
		but all three terms can vary so proportion unlikely	1	
		then EITHER if v is constant then P and F will also be constant		
		OR P is proportional to F when going up hills of different gradient		
		(at constant v)	1	2
		MAXIMUM 2		
	$A = \pi r^2$	yes (π is a constant and A is directly proportional to r^2)	1	1
	(b)	graph must be a straight line	1	
		graph must go through the origin	1	2
2	(a)	The air in the forest is heated and expands (so it becomes less dense)		1
		and rises 1		
		(cooler) air coming in to take its place (is the wind)	1	3
		{just saying convection current one of first two marks only}		
	(b)	A shiny surface reflects light	1	
		a black surface absorbs light	1	
		shoe itself is black because it does not reflect light	1	
		surface layer (transparent) or polish on shoe reflects light	1	
		reflection depends on texture of surface	1	3
		MAXIMUM 3		

(c)	the pendulum bob is travelling in a circle	1		
	so it is accelerating towards the centre	1		
	(it has a constant speed in the time interval just before vertical to just after vertical)			
	bob is not in equilibrium	1		
	so the tension must be (slightly) larger than the weight of the bob	1	3	
	MAXIMUM 3			
(d)	X-rays have a very small wavelength (compared with 0.1 mm)	1		
	angle of diffraction increases as size of opening decreases	1		
	little diffraction when size of opening is much greater than the wavelength	1		
	quantitative values - e.g. gap is 10^6 wavelengths	1	3	
	MAXIMUM 3			
(e)	sound waves are longitudinal waves	1		
	longitudinal waves cannot be polarised	1	2	
(f)	the heat is extracted from the air in the room	1		
	and pumped out the back of the refrigerator	1		
	the motor requires power	1		
	and its waste heat heats the kitchen	1	2	
	MAXIMUM 2			
3 **(a)**	(a lower resistance will) take a larger current from the supply	1		
	(power = $V \times I$) so power to/ brightness of headlamps is greater	1	2	
(b)	(first position) has no lights on at all	1		
	(second position just) lights the sidelights	1		
	(third position turns off the sidelights and) just illuminates the headlamps	1	3	
(c)	4 V across the internal resistance of the generator	1		
	so current = 4 V / 0.50 Ω = 8.0 A	1	2	

(d) (i)	12 V across headlamp		1	
	so current = 12 V / 4.0 Ω = 3.0 A		1	2
(ii)	power = *V x I*, total current = 6.0 A		1	
	power supplied = 12 V x 6.0 A = 72		1	
	watt		1	3
(e)	8 A from generator but only 6 A to headlamps		1	
	therefore current to battery is 2 A (allow –2 A)		1	
	battery is being charged		1	3
(f) (i)	constant voltage maintained across bulbs (and other components)		1	
	so brightness of bulbs does not vary (when other components			
	are being used		1	
	less energy wastage		1	
	can give high current (for starter motor)		1	2
		MAXIMUM 2		
(ii)	If the emf of the generator is (equal to or) less than the emf of the battery			
	it is impossible to have it supply more current than the circuit uses		1	
	Charging the battery is then impossible		1	
	battery would become discharged		1	
	or other valid response		1	2
		MAXIMUM 2		

4 (a) (i)	**radioactive** implies the emission of ionising radiation		1	
	OR emits alpha, beta and gamma radiation		1	1
(ii)	**nuclide** refers to a particular nuclear structure (with a stated number			
	of protons and neutrons)		1	
(iii)	**half-life** is the (average) time taken for the activity to fall to half its			
	original value		1	

(b)

time / hour	activity of material / Bq	activity of nuclide **X** /Bq	activity of nuclide **Y** /Bq
0	4600	4200	400
6	3713	3334	**379**
12	3002	2646	**356**
18	2436	**2100**	**336**
24	1984	**1667**	**317**
30	1619	1323	296
36	1333	**1050**	**283**

(i) and (ii)	2100 as first figure to be filled in for nuclide **X**	1	
	1667	1	
	1050	1	
	idea of subtraction for nuclide **Y**	1	
	correct values for the ones given in nuclide **Y** column	1	5
(c)	sensible graph plotted	1	
	extrapolation done	1	
	value 70 ± 5 hours	1	3
OR	$A = A_0 e^{-\lambda t}$	1	
	$\ln A = \ln A_0 - \lambda t$		
	e.g. when $A = 296$, $t = 30$ h		
	$5.6904 = 5.9915 - \lambda \times 30$	1	
	$0.3011/30 = 0.01004 = \lambda$		
	$\tau = \ln 2/\lambda = 69.0$ h answers will vary slightly dependent on starting and		
	finishing times	1	3

(d)	separate the two nuclides (before starting the count)	1	
	by chemical means (if possible)	1	
	OR using a centrifuge or diffusion (if isotopes)		
	OR sensible idea about shielding against one of the emitted particles		
(e)	decay constants or half lives are different	1	
	half-life at the start is approximately that for **X**	1	
	X decays more rapidly than **Y** so after a long time the half-life is that for **Y**	1	
	in between it has a value intermediate between the two (which varies)	1	3
	MAXIMUM 3		
	OR dealt with mathematically, along the lines of		
	two separate exponential decays	1	
	when added together do not give an exponential graph	1	
	with back up maths	1	3