

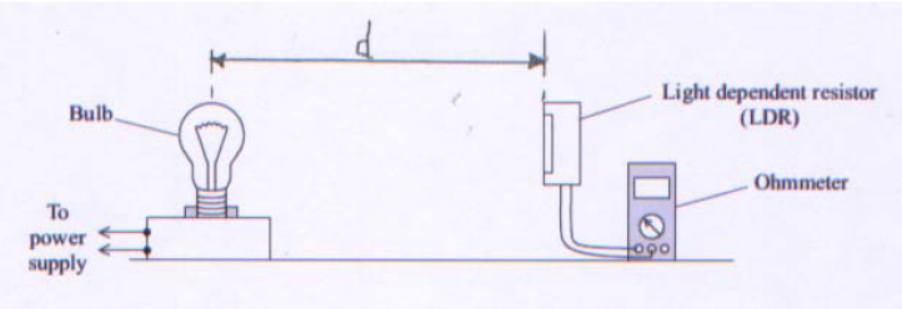
1.

(a)(i)	Precision is 1mm giving a small %U Or Precision is 1mm giving a %U of 0.3%	(1)	1
(a)(ii)	Take repeat readings (for both dimensions) and average Or Appropriate use of set square	(1)	1
(b)(i)	Max 2 (By measuring 32) the mean value of thickness is obtained (Measuring a larger thickness) gives a smaller %U Since thickness is now greater and instrument precision is the same Enables at least 2 SF measurement since thickness is now greater than 0.1mm (Do not credit precision or accuracy alone or 3SF)	(1) (1) (1) (1)	2
(b) (ii)	Micrometer (screw gauge) Or digital (vernier) callipers (not vernier callipers)	(1)	1
(c)(i)	Divides by 32 once (not 25) Or calculates volume with correct unit conversion Volume = $1.04 \times 10^{-6} \text{ (m}^3\text{)}$ to at least 3SF <u>Example of calculation</u> $0.301 \text{ m} \times 0.300 \text{ m} \times (3.69 \times 10^{-4} \text{ m})/32 = 1.04 \times 10^{-6} \text{ m}^3$	(1) (1)	2
(c)(ii)	Uses half ranges (or ranges) Or adds 3 % uncertainties To get between 5% - 6% (10% - 12%) <u>Example of calculation</u> $[(4/301) + (3/300) + (12/369)] \times 100\% = 1.3\% + 1.0\% + 3.3\% = 5.6\%$	(1) (1)	2
(c)(iii)	Density = $2390 \text{ (kg m}^{-3}\text{)}$ to 2/3 SF ecf their value for volume, Allow use of $1.0 \times 10^{-6} \text{ m}^3$ <u>Example of calculation</u> Density = $2.49 \times 10^{-3} \text{ kg} / 1.04 \times 10^{-6} \text{ m}^3 = 2390 \text{ kg m}^{-3}$	(1)	1
(c)(iv)	Calculates %D Comment based on comparison with %U Or Calculates maximum density value Compares this value with actual value <u>Example of calculation</u> $[(2750 - 2390)/2750] \times 100\% = 13\%$ %D (significantly) > %U so foil probably not pure aluminium	(1) (1) (1) (1)	2

2.

- (a) (i) reading from graph weight before take-off = 600 N
mass = $600/9.8(1) = 61.2$ kg [1] {1}
- (ii) reading from graph = 3280 ± 10 (N) [1] {1}
- (iii) reading from graph $g = 9.2$ N kg⁻¹ [1]
pull on astronaut = $9.2 \times 61.2 = 563$ N [1] {2}
- (b) (i) (fuel is burnt up so) mass of rocket gets less [1]
same force on less mass gives greater acceleration [1] {2}
OR less friction as atmosphere is less dense [1]
OR g less as distance from Earth increases [1]
so in these cases resultant force is greater [1]
- (ii) the graph only gives the magnitude of the force [1] {1}
momentum is a vector so direction would need to be constant [1] {2}
- (c) centripetal acceleration = value of g [1]
distance from Earth = $(6.71 - 6.37) \times 10^6 = 340$ km [1] {1}
which gives $g = 8.83$ m s⁻² from the graph [0]
- (d) (i) centripetal acceleration = 8.83 m s⁻² = v^2/r [1]
 $v^2 = 8.83 \times 6,71 \times 10^6$ [1]
 $v = 7700$ m s⁻¹ [1] {3}
- (ii) k.e. = $\frac{1}{2}mv^2 = \frac{1}{2} \times 61.2 \times (7700)^2$ [1]
 $= 1.81 \times 10^9$ J [1] {2}
-

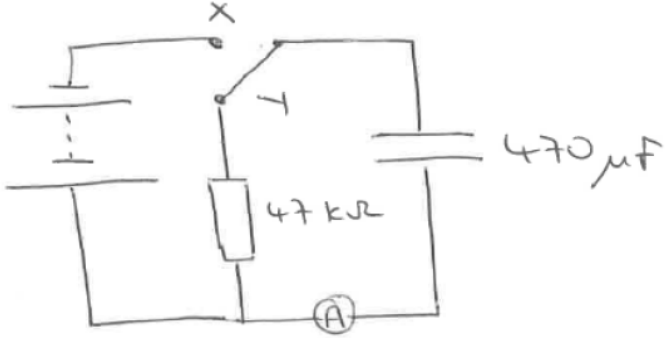
3.

(a)	Distance marked from filament (allow centre of bulb) to front surface of LDR (1)	1																												
																														
(b)	(As distance increases) light <u>intensity</u> decreases (and resistance increases with decreasing intensity) (1)	1																												
(c)	Light from other sources (1) Any suitable means of controlling outside light such as excluding it (darkened room) or using a tube as a shield on the LDR (1)	2																												
(d)	Shows expansion $\ln R = p \ln d + \ln k$ (1) Compares with $y = mx + c$ Or States that the gradient is p (1)	2																												
(e)	<table border="1" data-bbox="528 1055 1059 1294"> <thead> <tr> <th>d/m</th> <th>$R/k\Omega$</th> <th>$\ln(d/m)$</th> <th>$\ln(R/k\Omega)$</th> </tr> </thead> <tbody> <tr> <td>1.00</td> <td>1.79</td> <td>0</td> <td>0.582</td> </tr> <tr> <td>1.20</td> <td>2.24</td> <td>0.182</td> <td>0.806</td> </tr> <tr> <td>1.60</td> <td>3.32</td> <td>0.470</td> <td>1.200</td> </tr> <tr> <td>2.00</td> <td>4.04</td> <td>0.693</td> <td>1.396</td> </tr> <tr> <td>2.20</td> <td>4.70</td> <td>0.788</td> <td>1.548</td> </tr> <tr> <td>2.60</td> <td>5.50</td> <td>0.956</td> <td>1.705</td> </tr> </tbody> </table> <p data-bbox="316 1335 1190 1532"> \ln & \log values correct and to 3 SF consistently (allow 4SF for the values for $\ln R$ greater than one) (1) Labels & units on table & graph (1) Scales (1) Plots (1) Line of Best Fit (1) </p>	d/m	$R/k\Omega$	$\ln(d/m)$	$\ln(R/k\Omega)$	1.00	1.79	0	0.582	1.20	2.24	0.182	0.806	1.60	3.32	0.470	1.200	2.00	4.04	0.693	1.396	2.20	4.70	0.788	1.548	2.60	5.50	0.956	1.705	5
d/m	$R/k\Omega$	$\ln(d/m)$	$\ln(R/k\Omega)$																											
1.00	1.79	0	0.582																											
1.20	2.24	0.182	0.806																											
1.60	3.32	0.470	1.200																											
2.00	4.04	0.693	1.396																											
2.20	4.70	0.788	1.548																											
2.60	5.50	0.956	1.705																											
(f)(i)	Determines gradient with large triangle (at least half of the drawn line) (1) $1.13 < p < 1.23$ 3 SF and no units (1)	2																												
(f)(ii)	Records intercept $0.56 < c < 0.62$ (1) k found from anti-log of their intercept (1)	2																												

4.

(a)	The amplitude of the oscillation increases (1)	1
(b) (i)	Maximum correctly read to 3 SF from properly drawn curve (1) e.g. 1.60 Hz	1
(b) (ii)	Take more readings (1) At the turning point Or Around the resonant frequency (1)	2
(b) (iii)	More accurate Or Reduces random errors Or Reduces (percentage) uncertainty Or Allows many more readings to be taken in a given time (1)	1

5.

(a)	Current = 130 μA Meter range plausible and greater than their value (e.g. 200 μA) <u>Example of calculation</u> $I_0 = 6.0 \text{ V} / 47 \text{ k}\Omega = 128 \mu\text{A}$	(1) (1)	2
(b)	Calculates RC as $47 \text{ k}\Omega \times 470 \mu\text{F} = 22 \text{ s}$ [accept 22.1 s or 22.09 s] Record for a time equivalent to 3 - 5 times their time constant	(1) (1)	2
(c)	Precision (0.01 s) < human reaction time (0.1 s)	(1)	1
(d)	<i>Technique</i> Meter and stopwatch close together Or both in eye line at same time Or use of lap-timer (not repeat and average) <i>Safety</i> Capacitor connected correct way round Or capacitor rated voltage at least 6 V	(1) (1)	2
(e)	$\ln I = -t/RC + \ln I_0$ is same form as $y = mx + c$ and since RC is constant (hence the line is straight) (equation need not be seen if other valid statement made) $T = -1/\text{gradient}$ (must have negative sign)	(1) (1)	2
(f)(i)	Capacitor will require time to charge up (through the resistor) Or capacitor will not be fully charged	(1)	1
(f)(ii)	Suitable circuit drawn (values not needed) eg 	(1)	1

6.

- | | | | | |
|------|-------|--|--------------|-------|
| (a) | (i) | at highest point on the graph | (1) | [1] |
| | (ii) | mass is less | (1) | |
| | | less mass gives higher acceleration (for the same force) | (1) | [2] |
| | (iii) | rocket runs out of fuel | (so suddenly | |
| | | no upward force) | | |
| | | OR because fuel burns OR correct use of $F = ma$ | (1) | [1] |
| | (i) | weight | | (1) |
| | | air resistance / drag | (1) | [2] 6 |
|
 | | | | |
| (b) | (i) | P at position shown on sketch graph | (1) | |
| | | R showing range of constant velocity | (1) | [2] |
| | (ii) | recognises the need to find the area beneath the acceleration time graph | (1) | |
| | | 45 ± 5 small squares | (1) | |
| | | 1 small square = $0.4 \text{ (m s}^{-1}\text{)}$ so maximum velocity in range $16 - 22 \text{ m s}^{-1}$ | (1) | [3] 5 |
| (c) | | first section | (1) | |
| | | second section still increasing | (1) | |
| | | constant slope at end to zero height | (1) | [2] 3 |
-