OCR
Oxford Cambridge and RSA

Practice paper – Set 2

A Level Physics B (Advancing Physics)

H557/03 Practical skills in physics

MARK SCHEME

Duration: 1 hour 30 minutes

MAXIMUM MARK 100

FINAL

This document consists of 8 pages

Question			Solution	Marks	Guidance
1	a	i	top row: 8.61 (V) ✓ Third row: 2.32 (A) ✓ Bottom row: 21.0 (W) ✓	1 1 1	 Accept 20.97 to 4 sf
		ii	Mean Power = 20.6 W ✓ Uncertainty (half range), (21.0 – 19.8)/2 = ± 0.60 W ✓	1 1	
	b	i	Use of E = m c Δθ and P = E/t to give c = P t / m Δθ ✓ Use two readings off the graph and substitute. ✓ e.g. c = 20.6 x (10-2) x 60/ 1 x (29.1 – 19.9) = 1070 J kg^{-1} K^{-1} ✓	1 1 1	 Allow ECF from **(a)(ii)** t / Δθ = gradient = cm / P Ignore sign
		ii	Find gradient of cooling line of best fit from graph = −0.45 K min^{-1} ✓ Two plots read off correctly, at least half the length of the line apart. ✓	1 1	Acceptable range = -0.43 to -0.47 K min^{-1}
	c		Percentage difference = (1070 – 897)*100/897 = 19 % ✓ Percentage difference is larger than the percentage uncertainty so experiment is not very accurate ✓ Any two from: ✓✓ The block is cooling at rate calculated in **b(ii)**, which means that it should have had a larger temp difference; Heater not 100 % efficient; Energy has gone into heating heater/wires/digital thermometer; Temperature of the block may not have been uniform; Etc.	1 1 2	Allow ecf from **(b)(i)**
			Question total	14	

Question			Solution	Marks	Guidance
2	a		Suggested reason which would result in a larger time interval: ✓ Eg operator error in starting or stopping watch, released too high, etc.	1	**Reject** cupcake case given initial force/velocity unless clear that it is upwards
	b	i	Any four from: ✓✓✓✓ Initial acceleration is 9.81 $m\,s^{-2}$; No air resistance/only weight acting*; Velocity increases with decreasing acceleration; Because net downwards force = weight – air resistance and air resistance force increases with velocity*; Velocity eventually reaches terminal (constant) velocity; When weight is equal and opposite to air resistance*.	4	References to forces* must link to the relevant points to gain credit.
	b	ii	Initial start point and gradient same as original line ✓ Terminal velocity at larger value and flattening out at a later time ✓	1 1	

	b	iii	**Level 3 (5-6 marks)** ✓✓ Detailed description of procedure, measurements, calculations and mitigation of uncertainty for at least <u>two</u> methods. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is clear relevant and substantiated.* **Level 2 (3-4 marks)** ✓✓ Some description of procedure, measurements and calculations for at least <u>two</u> methods. **OR** Detailed description of procedure, measurements, calculations and mitigation of uncertainty for one method. *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.* **Level 1 (1-2 marks)** ✓✓ Limited description procedure, measurements and calculations for one method. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear*. **0 marks** No response or no response worthy of credit.	6	**Indicative Scientific points may include:** **Visual timing** • Metre rule & stopclock • Time from different heights • Plot average velocity against height • Identify trend • Reduce parallax **Time lapse photography.** • Ruler/tape measure as backdrop • Measure distance travelled between successive shots • Divide by time between shots. • Use value of velocity once it becomes constant. • Dark background easier to see against • Use high frame rate **Use of video** • Ruler and stopwatch in shot • Replay in slow motion • Record time to travel through a measured distance. • Don't use the acceleration part of trajectory/Start timing some distance below release point with pointers. • Dark background easier to see against • Use high frame rate **Use of data logger** • an ultrasound motion sensor connected to a below falling case. • Diagram of set up • Motion sensor records distance between sensor and cupcake case • Obtain plot of distance against time and find gradient for velocity.
			Question total	13	

Question			Solution	Marks	Guidance
3	a		$E = V q = 1.35 \times 1.6 \times 10^{-19} = 2.16 \times 10^{-19}$ J ✓	1	
	b	i	Combining E = V q <u>and</u> c = f λ with E = h f to give V q = h c/ λ ✓ Hence V = (h c /q) (1/ λ), (so gradient = h c /q) ✓	1 1	
	b	ii	Hence h = gradient x q/c $(= 2.0 \times 10^{-6} \times 1.6 \times 10^{-19}/3.0 \times 10^{8}) = 1.07 \times 10^{-33}$ J s. ✓	1	
	b	iii	Second line drawn within <u>all</u> horizontal error bars ✓ Gradient calculated correctly from two read offs ✓ Value for h calculated from gradient value ✓	1 1 1	

	b	iv	**Level 3 (5-6 marks)** ✓✓ Detailed quantitative comparison, explanation of the sources of error and improvements. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is clear relevant and substantiated.* **Level 2 (3-4 marks)** ✓✓ Some quantitative comparison, explanation of the sources of error and improvements **OR** detailed quantitative comparison <u>and</u> explanation of the sources of error <u>or</u> improvements **OR** detailed explanation of the sources of error <u>and</u> improvements. *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.* **Level 1 (1-2 marks)** ✓✓ Limited quantitative comparison **OR** explanation of the sources of error **OR** improvements. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear*. **0 marks** No response or no response worthy of credit.	6	**Indicative Scientific points may include:** **Comparison of values:** • Percentage difference calculated • Compare with percentage differences in V and λ. **Sources of error** • Difficult to tell exactly when LED turns on. • Eye may be more sensitive to some colours than others. • Uncertain of precise wavelength will be emitted when just visible. **Improved technique** • Use a darkened room/tube to view • Record V against I for each LED • Plot values of V and I on graph to find a better value for threshold value. • Sketch graph showing V-I characteristics for LED and how to find threshold voltage from graph.
			Question total	13	

Question			Solution	Marks	Guidance
4	a		Any 2 from: ✓✓ Handle radioisotope with tongs; Always point open side away from body; Keep exposure time as short as possible; Always store in lead lined containers.	2	
	b	i	Background radiation is always present/from cosmic rays and natural radioactive materials ✓ (The value for background count has to be subtracted from all readings) to avoid a systematic error ✓	1 1	
		ii	Half thickness calculated Method ✓ Evaluated ✓ More than one value found from the graph and mean calculated ✓	 1 1 1	Anticipated values in the range 0.9 to 1.1cm
	c	i	Ln taken on both sides and rearranged ✓	1	Expect to see $\ln(I) = \ln(I_0\, e^{-\mu x})$ $\ln(I) = \ln(I_0) + \ln(e^{-\mu x})$
		ii	All 4 data points plotted correctly ✓ Line of best fit drawn through the plots ✓	1 1	
		iii	Gradient correctly calculated from two points on the line drawn ✓ Intercept read off graph correctly or calculated using substitution into y = m x + c and coordinates of a point on the line ✓ μ = gradient ✓ $I_0 = e^{\text{intercept}}$ ✓	1 1 1 1	There must be evidence of this calculation. i.e. not just read from Fig. 4.2
	d	i	Use of $I = \frac{I_0}{2}$ ✓ Either $\frac{I_0}{2} = I_0\, e^{-\mu x}$ **OR** ln $(\frac{I_0}{2})$ = - μx + ln (I_0) and rearrange to $\frac{\ln 2}{\mu} = x_{1/2}$ ✓ $x_{1/2}$ = ✓	1 1 1	

		ii	Any three from ✓✓✓ On an exponential scale: Need to find several values of half-thickness in different parts of curve and average in order for it to be reliable ORA Radioactive decay is a random process and at small values of A the randomness will affect readings more. On a logarithm scale: Value determined for half-thickness from logarithm graph is more reliable as it is determined from the gradient of the line reducing the effect of the random nature of radioactive decay	3	i.e. Not reliable as only one/a few value(s) of half thickness calculated
			Question total	20	