British Physics Challenge – February 2003

Mark Scheme and Solutions

Total mark for each question is given in the extreme right column. Equivalent valid working should gain equal credit to the solution presented below. Incorrect units should not be penalized the first time, but then one mark should be deducted for a second offence. No further marks should be deducted for incorrect units. Use a similar procedure for inappropriate significant figures, that is, the use of more than 3 in a final answer.

1.		Take-off speed = 285 km/h = 2.85×10^5 m ÷ 3600s = 79.2 m/s	[1]	
		Acceleration = 79.2 m/s ÷ 30 s = 2.64 m/s^2	[1]	
		Force required for this accn. = $5.8 \times 10^4 \times 2.64$ = 153 kN	[1]	
		Capability of two engines = 2×90 kN = 180 kN		
		Any valid reason, for example friction, air resistance.	[1]	[4]

2.	*Either*:			
		Higher gravitational potential energy when furthest from Sun	[1]	
		Total energy constant for motion	[1]	
		Therefore lower kinetic energy when furthest from Sun	[1]	
		Therefore slower when furthest from Sun	[1]	[4]
	Or:			
		Any reference to ice-skater spinning faster when arms drawn in, *or* similar 'angular momentum' phenomenon	[1]	
		Reference linked to situation of a comet in an orbit	[1]	
		some form of mention of absence of tangential forces	[1]	
		Explanation in terms of angular momentum	[1]	[4]

3.	(a)	Energy transferred = 2000W × 84s = 168 kJ	[1]	
		Mass 500g = 0.5 kg, and temperature change = 80°C	[1]	
		Specific heat capacity = 168 kJ ÷ (0.5 kg × 80°C) = 4.2 kJ/kgK	[1]	
	(b)	Appropriate statement of conservation of energy.		
		e.g. energy same for heating just hot water as heating all to 20°C	[1]	
		Formation of equation: for example if mass of hot water is m, and hot water temperature is T then $mT + 10 \times 3m = 20 \times 4m$,	[1]	
		thus $T = 80 - 30 = 50$, therefore hot water is at 50°C.	[1]	[6]

4.	(a)	RED lamp: connect X to B, and A to Y.	[2]	
		GREEN lamp: connect X to A and Y to B	[2]	
	(b)	Connect M to B, and P to A	[1]	
		Connect N to A, and Q to B	[1]	
	(c)	Alternating Current supply (or just 'ac')	[1]	[7]

5.	(a)	Moment = Force × Distance to pivot	[1]	
		Distance must be measured perpendicular to force ·	[1]	
	(b)	Appropriate apparatus and procedure	[1]	
		Explanation of how mass of apple would be calculated.	[1]	

Question continued over the page.