Oxford Cambridge and RSA

Practice paper – Set 1

H556/01 Modelling physics

MARK SCHEME

Duration: 2 hours 15 minutes

MAXIMUM MARK 100

FINAL

This document consists of 10 pages

MARKING INSTRUCTIONS

Generic version as supplied by OCR Sciences

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

SECTION A

Question	Answer	Marks	Guidance
1	A	1	
2	D	1	
3	D	1	
4	B	1	
5	A	1	
6	A	1	
7	A	1	
8	C	1	
9	C	1	
10	A	1	
11	B	1	
12	B	1	
13	C	1	
14	C	1	
15	C	1	
	Total	15	

SECTION B

Question			Answer	Marks	Guidance
16	(a)		Distance travelled from the moment the driver sees a hazard until the brakes are applied Distance proportional to speed (for constant thinking time)	B1 B1	
	(b)	(i)	$a = F / m$ / $a = 8700 / 2300$ $a = 3.8$	C1 A1	**Note** answer is 3.78 to 3 s.f.
		(ii)	$D_{thinking} = u \times t = 22 \times 0.97 = 21.3$ (m) $D_{braking} = u^2 / 2a$ or $22^2 / (2 \times 3.8) = 64.0$ (m) stopping distance = $D_{thinking} + D_{braking}$ or 21.3 + 64.0 stopping distance = 85.3 (m)	C1 C1 C1 A0	Allow 21.34 Allow 63.98 Allow ecf Allow 85.32
		(iii)	$22 \times 3600 / 1600$ (= 49.5 mph)	B1	
		(iv)	Thinking distance for truck longer than in chart Suggested reason e.g. tired Braking distance for truck longer than in chart Suggested reason e.g. truck more massive than a car, truck's brakes are poor quality	B1 B1 B1 B1	 Allow any relevant factor Ignore reference to road conditions
			Total	**12**	

Question			Answer	Marks	Guidance
17	(a)		(For a system in equilibrium) the sum of the clockwise moments (about the same point) = sum of anticlockwise moments	B1	**Allow** total / Σ / resultant for ‘sum’ **Allow** the sum of moments = 0
	(b)	(i)	(Clockwise moment) $T \sin 50^{\circ} \times 0.030$ (Anticlockwise moment) 260×0.40 $T \sin 50^{\circ} \times 0.030 = 260 \times 0.40$ $T = 4500$ N	C1 C1 A1	 **Allow** N cm **Allow** 4525 N
		(ii)	Perpendicular distance of weight to *P* decreases So *T* must decrease.	M1 A1	
			Total	**6**	

Question			Answer	Marks	Guidance
18	(a)		volume = $\pi \times 0.035^2 \times 0.085 = 0.000327$ $m = \rho V = 1000 \times 0.000327$ mass = 0.33 (kg)	C1 C1 A0	
	(b)		number of moles = 0.327 / 0.018 = 18.17 number of molecules = $18.17 \times N_A$ number of molecules = 1.1×10^{25}	C1 A1	
	(c)		energy input = $mc\Delta\theta = 0.327 \times 4200 \times 80 = 110$ kJ energy input = power × time time = 220 (s)	C1 M1 C1 A0	Allow 0.3 kg in the calculation
	(d)		Thermal losses to kettle and surroundings Lagging the kettle Cover to prevent evaporation	B1 B1 B1	
			Total	**10**	

Question			Answer	Marks	Guidance
19	(a)		work done = force $\times$ distance moved or displacement in the direction of the force	B1	
	(b)	(i)	tension = 850 kg $\times$ 9.81 = 8300 N	B1	
		(ii)	work done = mgh = 850 $\times$ 9.81 $\times$ 12 work done = 100 kJ output power = 100 $\times$ 10^3 / 40 (=2501 W) input power (= 2501 / 0.6) = 4200 (W)	C1 C1 C1 A1	
		(iii)	Suggestion to reduce heat losses through friction in moving parts e.g. oil, bearings Use a stiffer/stronger cable to reduce energy loss through stretching	B1 B1	
			Total	**8**	

Question			Answer	Marks	Guidance
20	(a)		Smoke particles show random / haphazard motion (wtte) This is because of collisions with air molecules/particles.	B1 B1	Accept a correctly labelled diagram for this B1 mark.
	(b)		Any **three** from: • Forces between particles are negligible except during collisions • Collisions are perfectly elastic • Time of a collision is negligible compared to time between collision • Particles / atoms / molecules occupy negligible volume compared to volume of gas • Large number of molecules in random motion.	B1× 3	
	(c)	(i)	T = 293 K $3/2\ kT = ½\ mv^2$ $3/2 \times 1.38\text{x}10^{-23} \times 293 = ½ \times 4.7\text{x}10^{-26} \times v^2$ v = 510 (m s^{-1})	M1 C1 M1 A0	 Note answer is 509.8 m s^{-1} to 4 s.f.
		(ii)1	Total vertical momentum after = 0 Total vertical momentum before = 0 (momentum is conserved)	B1 B1	
		(ii)2	$4.7 \times 10^{-26} \times v \times \sin 88^{o} = 1.4 \times 10^{-24} \times 23 \times \sin 45^{o}$ v = 480 (m s^{-1})	C1 A1	 **Allow** other correct methods.
			Total	**12**	

Question			Answer	Marks	Guidance
21	(a)		(Resultant) Force acts perpendicularly to the direction of motion	B1	
	(b)	(i)	$F = 5.0 \times 4.8^2 / 1.5$ $F = 77$ (N)	C1 A1	**Allow** 76.8 (N)
		(ii)	$\omega = v / r = 4.8 / 1.5$ $\omega = 3.2$ (rad s^{-1})	C1 A1	**Allow** alternative e.g. $F = m\,\omega^2\,r$
	(c)*		**Level 3 (5-6 marks)** A labelled diagram including all equipment required and a detailed description of the method leading to an appropriate analysis of data. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3-4 marks)** A labelled diagram including most of the equipment required and a description of the method leading to an appropriate graph but with some misunderstanding of the relationship. *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)** A diagram is included with most of the equipment required and a description of the method leading to an attempt of identifying an appropriate graph or relationship. *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.*	B1 × 6	**Equipment/labelled diagram(E)** 1. String/cord (passed through a tube) with bung at one end and load at other (accept a labelled diagram) 2. Stopwatch to measure time period 3. Suitable scale/marker to measure radius **Method (M)** 1. Whirl bung with constant frequency and radius (in horizontal circle) 2. Measure time for several time periods 3. Measure radius either using cord markers or stopping the cord at the tube and measuring with a ruler 4. Vary frequency and new radius **Analysis (A)** 1. Expect $v^2 \propto r$, or $r \propto T^{-2}$ 2. Plot graph; e.g r against T^{-2} 3. Expect straight line through origin
			Total	**11**	

Question			Answer	Marks	Guidance
22	(a)		Labelled diagram showing a line joining a planet and the Sun Comparing swept areas at different parts of orbit	B1 B1	
	(b)		Arrow acting along line from planet towards sun	B1	Any arrow length
	(c)		Appropriate test proposed, e.g. T^2 / r^3 = constant k Test carried out on **all** three pairs of data Conclusion consistent with test result	B1 M1 B1	$k = (1.112, 1.109, 1.113) \times 10^{-5}$ respectively
			Total	**6**	

Question			Answer	Marks	Guidance
23	(a)		Recessional speed / velocity of <u>galaxy</u> is proportional to its distance (from us)	B1	
	(b)	(i)	Velocity determined by Doppler shift of spectral lines	B1	
		(ii)	Suitable straight line of best fit though origin Appropriate pair of values (d, v) taken from line, $H_0 = v/d$ $400 \text{ km s}^{-1} \text{ Mpc}^{-1} \le H_0 \le 600 \text{ km s}^{-1} \text{ Mpc}^{-1}$	M1 M1 A1	
		(iii)	$H_0 = 500 \times 10^3 / 10^6 \times 3.1 \times 10^{16} = 1.6 \times 10^{-17} \text{ s}^{-1}$ $t = 1 / H_0 = 1 / 1.6 \times 10^{-17} = 6.2 \times 10^{16}$ s age = 2.0×10^9 (years)	C1 C1 A1	Accept answers between 1.6×10^9 (years) and 2.5×10^9 (years) CF
	(c)	(i)	(Stronger) gravitational attraction between nearby galaxies affects motion / clustering of galaxies	B1	
		(ii)	Expansion rate may not have been constant / non-linear expansion / effect of dark energy causing accelerating rate of expansion	B1	
			Total	**10**	

Question			Answer	Marks	Guidance
24	(a)		Use of a metre rule with ± 1 mm Suitable experimental method to ensure accuracy, e.g. avoid parallax error	B1 B1	
	(b)		3.6 ± 0.4 ($m^2 s^{-2}$)	B1	
	(c)	(i)	Data point and error bar correctly plotted	B1	**Allow** ecf from **(b)**
		(ii)*	**Level 3 (5–6 marks)** Detailed analysis of the graph clearly linked to the principle of conservation of energy, including determination of the value of *g* and the related uncertainty in the answer. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Analysis of the graph linked to kinetic energy and/or potential energy, with an attempt to find the value of *g*. Mention of where one would find uncertainties in the answer but without analysis. *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)** Line of best fit drawn and gradient attempted. Mention of energy and/or where uncertainties may occur. *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.	B1 × 6	**Explanation** 1. Principle of conservation of energy used to derive relationship. 2. $mgh = ½ mv^2$ or $v^2 = 2gh$ 3. A graph of v^2 against h will be a straight line (through the origin). 4. Gradient of line = 2*g* **Determination** 1. Line of best fit drawn through all data points. 2. Gradient in the range 17 to 21 ($m^2 s^{-2}$) 3. *g* determined correctly from the gradient. **Uncertainty** 1. Worst line of fit drawn 2. Correct attempt to determine the uncertainty.
			Total	**10**	