Practice paper– Set 1

H556/03 *Unified Physics*

MARK SCHEME

Duration: 1 hour 30 minutes

MAXIMUM MARK 70

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.

Question			Answer	Marks	Guidance
1	(a)		power or P: kg m^2 s^{-3}	B1	power = force x distance/time = force x velocity
	(b)	(i)	1. *either* resultant force $F = ma - R$ *or* resultant force decreases as R increases 2.acceleration a decreases to zero when $F = R$ 3.velocity rises from zero to a terminal/maximum value when $F = R$	B1 B1 B1	**allow** for points 2 and 3 *when* $F = R$ appearing only once
		(ii)1	initial acceleration is 40/120 = 0.33 (m s^{-2})	B1	
		(ii)2	from the graph Rv = 200 (W) so R = 40 N and terminal velocity v is 5 (m s^{-1})	C1 A1	**or** forward force = 40 N so R = 40 N for constant speed/zero acceleration
	(c)		p.e./second = mgvsin θ = 120 x 9.81 x 5 x sin θ extra power= 200 (W) so sin θ = 1/29.4 giving x = 29 m	C1 C1 A1	**allow** force downhill F = mgsin θ, extra power = Fv
			Total	**10**	

Question			Answer	Marks	Guidance
2	**(a)**		$eV = \frac{1}{2}mv^2$ so $v^2 = 2eV/m$ $ma = eE$ so $a = eE/m$ $x = vt$ $d = \frac{1}{2}at^2 = \frac{1}{2}a(x/v)^2$ $d = (eE/2m).x^2.(m/2eV) = Ex^2/4V$ $x^2 = 4(d/E)V$	**B1** **B1** **B1** **B1** **B1** **A0**	four equations are needed and some sensible substitution, etc. shown for the fifth mark
	(b)	**(i)**	22.1 ± 0.9	**B1**	value plus uncertainty both required for the mark allow ± 1.0
		(ii)	two points plotted correctly, including error bars; line of best fit worst acceptable straight line.	**B1** **B1**	**ecf** value and error bar of first point **allow ecf** from points plotted incorrectly steepest or shallowest possible line that passes through <u>all</u> the error bars; should pass from top of top error bar to bottom of bottom error bar **or** bottom of top error bar to top of bottom error bar
			gradient (= 4d/E) = 2.4 ± 0.4; $E = 4 \times 2.0 \times 10^{-2} / 2.4 \times 10^{-6} = 3.3 \times 10^4$ $(3.3) \pm 0.6 \times 10^4$ $V\ m^{-1}$ or $N\ C^{-1}$	**B1** **B1** **B1** **B1**	**allow** 2.4 ± 0.5 0.1/4 + 0.4/2.4 = 0.192 x 3.3 = 0.63 0.1/4 + 0.5/2.4 = 0.233 x 3.3 = 0.77 **allow** $3.3 \pm 0.8 \times 10^4$
			Total	**12**	

Question			Answer	Marks	Guidance
3	(a)		when pressure or volume of an ideal gas tends to zero, the temperature must tend to zero; the temperature scale with this zero of temperature is the kelvin scale/AW	B1 B1	
	(b)		pV/T = constant $(1.0\times10^5 V)/290 = (1.0 \times 10^3 \times 1.0\times10^6)/230$ $V = 1.26 \times 10^4$ (m^3)	B1 B1 B1	
	(c)	(i)	$n = pV/RT = 1.0 \times 10^5 \times 1.26 \times 10^4/(8.31 \times 290)$ $n = 5.2 \times 10^5$	B1 B1	**ecf (b)** **allow** 5.4×10^5 using 1.3×10^4
		(ii)	$4.0 \times 10^{-3} \times 5.2 \times 10^5 = 2.1 \times 10^3$ (kg)	B1	**ecf (c)(i)**
	(d)		(internal energy $\propto T$) $E = 1900 \times 230/290 = 1500$ (MJ)	B1	
	(e)		$U = \rho Vg = 1.3 \times 1.26 \times 10^4 \times 9.81 = 1.61 \times 10^5$ $Ma = U - Mg$ $27 M = 1.6 \times 10^5 - Mg$ giving $M = 4.3 \times 10^3$ kg	C1 C1 A1	**or** $1.3 \times 1.3 \times 10^4 \times 9.81 = 1.66 \times 10^5$ $M = 4.6 \times 10^3$ kg
			Total	**12**	

Question			Answer	Marks	Guidance
4	(a)		Grav. potential V_g at a point is defined as the work done to bring 1 kg from infinity to that point in space; (G) force is attractive so the work done is negative (as separation is decreasing); V_g is given the value zero at infinity so is negative nearer the Earth.	B1 B1 B1	 **or** work is required to move away from the Earth/AW
	(b)	(i)	$F = GMm/r^2 = mv^2/r$ $v = (GM/r)^{1/2} = (g/r)^{1/2}R$ (as $g=GM/R^2$) $v = 7.7$ (km s^{-1}.).	C1 C1 A1	where $r = 6.8 \times 10^6$ m **N.B.**some working must be shown as a *show that* Q
		(ii)	total energy = $½mv^2 - GMm/r = -GMm/2r$ $E = -gR^2m/2r = -1.2(4) \times 10^{13}$ (J)	M1 A1	**no ecf from (b)(i); allow** numerical values with no algebra if clear **no mark for** correct value without the minus sign
	(c)		**see page 7**	B1 x 6	
			Total	**14**	

Question			Answer	Marks	Guidance
4	(c)		**Level 3 (5 - 6 marks)** a structured combination of at least 6 statements taken from A, B and C or A and D a combination of at least 5 statements; script of a lower quality **N.B.** bonus given for any of E at any level *The ideas are well structured providing significant clarity in the communication of the science.* **Level 2 (3 – 4 marks)** a good combination of at least 4 statements taken from A and B or A and C or B and C or A and D a combination of at least 3 statements taken from two sections which are relevant together. *There is partial structuring of the ideas with communication of the science generally clear.* **Level 1 (1 – 2 marks)** at least 2 statements from A, B, C or D which are relevant together some attempt which is related to the question *The ideas are poorly structured and impede the communication of the science.* **Level 0 (0 marks)** Insufficient or relevant science.	B1 x 6	**A initial scenario** • for circular orbit a centripetal force (of magnitude mv^2/r) is required or AW in terms of accelerations • this is provided by the gravitational force GMm/r^2 **or** G force just pulls radially inwards sufficiently to maintain orbit • the speed in orbit $v = (GM/r)^{1/2}$ **B reverse thrust** • G force causes rocket to spiral towards Earth when rocket slowed; • rocket speeds up in process • v in orbit is larger when radius r is smaller; condition for faster lower orbit can be achieved **or** T smaller because either v is larger or r/circumference is smaller or both or $2\pi r/v$ is smaller **C forward thrust** • when rocket speeds up with engines fired forwards G force insufficient to hold orbit so spirals to larger orbit • slowing as it does so **D energy approach** • some p.e. goes to k.e. when rocket is slowed as it moves towards Earth • so v increases • vice versa when rocket is accelerated **E further comments** • extra corrections needed to obtain circular orbit after manoeuvre (not mentioned in passage) • any other relevant statement not included above

Question			Answer	Marks	Guidance
5	**(a)**	**(i)**	F upwards between poles	**B1**	
		(ii)	F = BIl = 0.032 x 2.5 x 0.06 = 4.8×10^{-3} (N)	**B1**	
	(b)	**(i)**	a = (-) $4\pi^2 f^2 x$ = 4 x 9.87 x 4900 x 0.004 a = 770 (m s^{-2})	**C1** **A1**	**allow** 774 (m s^{-2})
		ii)1	sketch showing one wavelength and 140 (Hz)	**B1**	both sketch and value required for 1 mark
		(ii)2	driving force is around nodal point/AW; points either side of nodal point try to move in opposite directions when force in one direction/AW; move magnet to antinodal point; ¼ of distance between clamps	**B1** **B1** **B1**	**max** 3 of the 4 marking points **not** increase current
	(c)	**(i)**	*f* α √T so f= 70/√2 = 49 or 50 Hz	**B1**	
		(ii)1	μ increases/goes up by 0.4%	**B1**	**allow** + 0.4% NOT 0.4%
		(ii)2	0.2%, f is lower because μ is bigger and μ is on the bottom of the formula	**B1** **B1**	**or** half of answer to **(ii)1** **or** greater inertia present with same restoring force/other physical argument
			Total question 5	**16**	

Question			Answer	Marks	Guidance
6	(a)		**see page 10**	**B1 x 6**	
	(b)	**(i)**	Two closed loops linking primary coil	**B1**	lines not touching/crossing, both passing only through iron core
		(ii)	magnetic flux φ: because the loops of magnetic field (are continuous and) all pass (through the iron core) through each coil	**B1**	**allow** magnetic flux is the number of lines of the magnetic field if **(b)(i)** is correct
		(iii)	for magnetic flux density: 3 turn coil as A is smallest OR for magnetic flux linkage: 5 turn coil as largest number of turns	**B1** **B1**	Note: b(iii) and b(iv) can be answered in either order φ is same in each coil, B = φ/A OR φ is same in each coil, m.f.l. = φN
			Total	**10**	

Question			Answer	Marks	Guidance
6	(a)		**Level 3 (5 - 6 marks)** A good plan with discussion of sensitivity and measurements that need taking. Detailed description of analysis needed linked to robust conclusions and consideration of a fair test. extra points from sections may balance omissions from others *The ideas are well structured providing significant clarity in the communication of the science.* **Level 2 (3 – 4 marks)** A good plan possibly with mention of sensitivity. Measurements that need taking should be described. Analysis linked to conclusions and possibly consideration of a fair test. extra points from sections may balance omissions from others *There is partial structuring of the ideas with communication of the science generally clear.* **Level 1 (1 – 2 marks)** A plan with discussion of measurements that need taking. Description of analysis needed linked to a conclusion. *extra points from sections may balance omissions from others* *The ideas are poorly structured and impede the communication of the science.* **Level 0 (0 marks)** Insufficient relevant science.	**B1 x 6**	**plan P** • investigate one variable with the other fixed • oscilloscope time base can be off • do rough preliminary test over range of variable to check that there is a suitable variation in oscilloscope V • choose and fix f of I and value of other variable (M3); • measure e.m.f. V for 5 or 6 settings of variable from oscilloscope screen **sensitivity S** • magnitude of detected signal depends on rate of change of flux linkage/Faraday's law through search coil • so increases with f and B (N and A of search coil are fixed) • for large B use small ***L*** f changing N **or** large N if changing ***L*** **measurements M** • measure (maximum) e.m.f. V (using V/cm scale setting) on oscilloscope • measure peak to peak distance on graticule if time base not switched off • keep ***L*** fixed and adjust croc. clips to change N **or** keep N fixed and alter ***L*** (use ruler) **analysis A** • record table of V against *N* or ***L*** • plot graph of V against *N* or 1/ ***L*** **conclusions C** • straight line graph • through origin is expected • to validate given relationship **fair test F** • ensure that Slinky coils are uniformly spaced and not touching together anywhere • croc. clips make good contact at only one point on coil • plane of coil must be vertical **and** coaxial with Slinky