Multiple Choice Answers

Q36: D

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Q5: D
Q6: D
Q10: D
Q12: A
Q14: C
Q15: C
Q18: C
Q22: B
Q23: C
Q24: A
Q39: A

1	**Defining the problem**
	vary m and measure f **or** m is the independent variable and f is the dependent variable
	keep f_0 <u>constant</u>
	Methods of data collection
	labelled diagram of workable experiment including: • turntable base and motor on bench • two labels from turntable, motor, belt, C, putty, bench, release mechanism
	workable circuit showing terminals of motor connected to (d.c.) supply
	method to measure time to determine f and f_0, e.g. use a stopwatch to measure (n)t **and** method to measure m, e.g. use a (top-pan) balance
	measure the time t for n revolutions **and** $T = t / n$ **and** $f = 1 / T$ **or** $f = n / t$
	Method of Analysis
	plots a graph of $\frac{1}{f}$ against m or equivalent Do not accept logarithms.

1	$\frac{1}{f}$ against m	m against $\frac{1}{f}$
	$K = \dfrac{r^2}{f_0 \times \text{gradient}}$	$K = \dfrac{r^2 \times \text{gradient}}{f_0}$
	$\frac{1}{f}$ against m	m against $\frac{1}{f}$
	$\beta = f_0 \times y$-intercept	$\beta = -\dfrac{f_0 \times y\text{-intercept}}{\text{gradient}}$ **or** $\beta = -\dfrac{r^2 \times y\text{-intercept}}{K}$

1	**Additional detail including safety considerations**	
	D1	precaution linked to putty leaving turntable, e.g. screens around apparatus / cushions to prevent putty from leaving bench
	D2	keep r constant
	D3	use rule(r) to measure r
	D4	stand and fixed point located above P (to ensure r is constant)
	D5	method to ensure putty is dropped at (constant) distance r, e.g.; fixed location above the turntable to drop putty to keep r constant **or** draw a circle of radius r on the turntable
	D6	method to keep f_0 constant, e.g. adjust the rheostat to keep the current in the motor constant / check ammeter
	D7	clamp motor and/or turntable (base) to bench
	D8	lubricate the turntable to reduce friction
	D9	repeat experiment for the same value of m **and** determine the average f
	D10	relationship valid if a straight line is produced (with y-intercept = $\frac{\beta}{f_0}$) Do not accept line through the origin.

1(a)	(gravitational) force is (directly) proportional to product of masses
	force (between point masses) is inversely proportional to the square of their separation
1(b)(i)	(gravitational) force acts perpendicular to direction of motion
	gravitational force provides centripetal acceleration
1(b)(ii)	(F =) $GMm / x^2 = mx\omega^2$ **and** $\omega = 2\pi / T$ **or** $GMm / x^2 = 4\pi^2 mx / T^2$
	completion of algebra leading to $x^3 = GMT^2 / 4\pi^2$
	clear indication that B = radius of planet **and** that A = mass (of planet)
1(b)(iii)	gradient = $\sqrt[3]{(4\pi^2 / GA)}$
	e.g. $(1280 - 360) / (12 \times 10^6) = \sqrt[3]{(4\pi^2 / [6.67 \times 10^{-11} \times A])}$
	$A = 1.3 \times 10^{24}$ kg
	intercept = gradient $\times B$
	e.g. $360 = ((1280 - 360) \times B) / (12 \times 10^6)$ $B = 4.7 \times 10^6$ m

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1(a)	work done per unit mass
	work done moving mass from infinity (to the point)
1(b)(i)	potential is zero at infinity
	work is done **by** (two) masses in moving them **closer** together **or** work is done **on** (two) masses in moving them **apart**
1(b)(ii)	magnitude of potential shown as 4Φ
	potential negative **and** shown as a multiple of $-\Phi$ [potential = -4Φ if fully correct]
1(b)(iii)	field strength at X: $\Phi / 4R$
	field strength at Y: $4\Phi / R$
	potential energy at X: $-M\Phi$
	potential energy at Y: $-8M\Phi$

2(a)	horizontal force on sphere causes centripetal acceleration
	weight of sphere is (now) equal to vertical component of tension **or** horizontal and vertical components (of force) (now) combine to give greater tension (in spring)
	greater tension in spring so greater extension of spring
2(b)(i)	$r = 10.8 \times \sin 27° = 4.9\,\text{cm}$
2(b)(ii)	$T \cos \theta = mg$ **or** $T \cos \theta = W$ **and** $W = mg$
	$T \cos 27° = 0.29 \times 9.81$ leading to $T = 3.2\,\text{N}$
2(b)(iii)	$\Delta T = 3.2 - (0.29 \times 9.81)$
	$k = \Delta T / \Delta x$ $= [3.2 - (0.29 \times 9.81)] / [10.8 - 8.5]$ $= 0.15\,\text{N cm}^{-1}$
2(c)(i)	centripetal acceleration $= (T \sin \theta) / m$ $= (3.2 \times \sin 27°) / 0.29$
	$= 5.0\,\text{m s}^{-2}$
2(c)(ii)	$a = r\omega^2$ **and** $\omega = 2\pi / T$ **or** $a = v^2 / r$ **and** $v = 2\pi r / T$
	$T = 2\pi \times \sqrt{(0.049 / 5.0)}$ $= 0.62\,\text{s}$

1(a)	work done per unit mass
	work (done on mass) moving mass from infinity (to the point)
1(b)(i)	-3.55×10^{7} J kg^{-1}
1(b)(ii)	$\phi = -\dfrac{GM}{r}$ $M = -\dfrac{-3.55\times10^{7}\times4800000}{6.67\times10^{-11}}$ $= 2.55 \times 10^{24}$ kg
1(b)(iii)	$g = \dfrac{GM}{r^2}$ **or** $g = -\dfrac{\phi}{r}$
	$= \dfrac{6.67\times10^{-11}\times2.55\times10^{24}}{4800000^2}$ **or** $= \dfrac{3.55\times10^{7}}{4800000}$ $= 7.4$ N kg^{-1}
1(b)(iv)	r in range 2.60×10^{7} to 2.65×10^{7} m
	$\dfrac{mv^2}{r} = \dfrac{GMm}{r^2}$ **and** $v = \dfrac{2\pi r}{T}$ **or** $mr\omega^2 = \dfrac{GMm}{r^2}$ **and** $\omega = \dfrac{2\pi}{T}$
	$T^2 = \dfrac{4\pi^2 r^3}{GM} = \dfrac{4\pi^2\times\left(2.65\times10^{7}\right)^3}{6.67\times10^{-11}\times2.55\times10^{24}} = 4.20 \times 10^{9}$
	$T = 64\,800$ s $= 18$ hours
1(c)	similarity – any one point from • inversely proportional to distance (from point) • points of equal potential lie on concentric spheres • zero at infinite distance
	difference – any one point from • gravitational potential is (always) negative • electric potential can be positive or negative