EUNOIA JUNIOR COLLEGE
JC1 Promotional Examination 2019
General Certificate of Education Advanced Level
Higher 2

PHYSICS **9749**

MARK SCHEME

Sep/Oct 2019

Paper 1
Multiple Choice

Q	*Key*	*Q*	*Key*	*Q*	*Key*	*Q*	*Key*	*Q*	*Key*	*Q*	*Key*
1	**B**	6	**C**	11	**C**	16	**B**	21	**C**	26	**B**
2	**C**	7	**B**	12	**B**	17	**D**	22	**D**	27	**A**
3	**D**	8	**C**	13	**C**	18	**B**	23	**A**	28	**B**
4	**A**	9	**D**	14	**C**	19	**D**	24	**C**	29	**A**
5	**D**	10	**B**	15	**D**	20	**A**	25	**A**	30	**C**

1 radius of Earth ~ 4x of Moon
so select item ~ 3 cm radius: tennis ball

2 **[unorthodox question, can afford to ignore]**

the uncertainty of 1% applies on the extreme values obtained

$$\langle I \rangle = 3.06 \text{ A}$$

$$\Delta I_{\text{min}} \approx \left(\frac{1}{100}\right)(3.04) \approx 0.03 \text{ A}$$
$$I_{\text{min}} = 3.04 - 0.03 = 3.01 \text{ A}$$

$$\Delta I_{\text{max}} \approx \left(\frac{1}{100}\right)(3.08) \approx 0.03 \text{ A}$$
$$I_{\text{max}} = 3.08 + 0.03 = 3.11 \text{ A}$$

$$\Delta I = \frac{1}{2}\left(I_{\text{max}} - I_{\text{min}}\right) = 0.05$$

$$I = 3.06 \pm 0.05 \text{ A}$$

3 using $v^2 = u^2 + 2as$

$$v_A^2 = u_A^2 + 2g\left(y_A\right)$$
$$\left(\frac{v_A}{4}\right)^2 = u_A^2 + 2g\left(y_B\right)$$

$$v_A^2 - 2g\left(y_A\right) = \left(\frac{v_A}{4}\right)^2 - 2g\left(y_B\right)$$
$$16v_A^2 = v_A^2 - 32g\left(y_B - y_A\right)$$
$$15v_A^2 = 32(9.81)(3.06)$$
$$v_A = \sqrt{\frac{32(9.81)(3.06)}{15}} = 8.0 \text{ m s}^{-1}$$

4 acceleration from X so eliminate C and D (constant initial speed)

constant speed thereafter so eliminate B

5 constant horizontal speed so eliminate AB for horizontal displacement with time

loss in KE is gain in GPE so negative gradient of straight line for KE vs s_y expected

even at highest point there is KE associated with horizontal velocity so eliminate Graph 2

6 Consider 2 kg & 3 kg as combined mass
$F = ma$
$= (2+3)(2) = 10\ \text{N}$

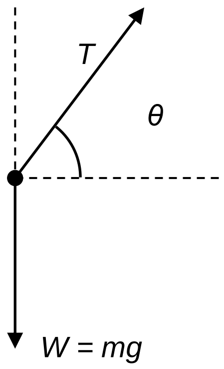
OR

Consider total mass
$F = ma$
$$a = \frac{F}{2+3+4} = \frac{F}{9} = 2$$
$F = 18\ \text{N}$

Consider 2 kg mass:
$T_{\text{btwn 2 and 3}} = ma$
$$= (2)\frac{F}{9} = 4\ \text{N}$$

Consider 3 kg mass:
$T_{\text{btwn 3 and 4}} - T_{\text{btwn 2 and 3}} = ma$
$T_{\text{btwn 3 and 4}} = 3(2) + 4 = 10\ \text{N}$

7 Free-body diagram:



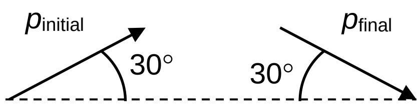
vertical equilibrium
$T\ \sin\theta = mg$

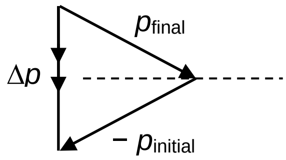
horizontal acceleration
$T\ \cos\theta = ma$

$$\tan\theta = \frac{g}{a} = 2$$
$$\theta = 63.4°$$

angle wrt vertical is 26.6°

8 momentum so think vectorially





$\Delta p = p_{\text{final}} - p_{\text{initial}}$
$= p\ \sin(30°) + p\ \sin(30°)$
$= p = mv$

9 A: climbs at constant speed, nett force is zero, can be in equilibrium

B: constant altitude so vertical equilibrium, if horizontal speed is constant then glider can be in equilibrium

C: if ship is constant velocity, nett force is zero, can be in equilibrium

D: changing direction is changing acceleration implies net force, not in equilibrium

10 Recall "origin of upthrust"

11 think of both translational & rotational equilibrium

translational eqm: $W = 16 + 9 = 25$ kN

By POM, pivot about front wheels,
sum of ↻ moments = sum of ↺ moments,
$Wx = 9(1.5)$
$$x = \frac{9(1.5)}{25} = 0.54\ \text{m}$$

CG is 0.54 after front wheels so 1.14 from front.

12 EPE = KE left + w.d. against friction
(no change in GPE)
$$\text{KE} = \frac{1}{2}kx^2 - fd$$

13 max speed → no net force

$$F_{\text{engine}} - f_{\text{resistance}} = 0$$

$$\begin{aligned} F_{\text{engine}} &= f_{\text{resistance}} \\ &= kv^2 \\ k = \frac{F_{\text{engine}}}{v^2} &= \frac{\frac{P_{\text{engine}}}{v}}{v^2} \\ &= \frac{P_{\text{engine}}}{v^3} \\ &= \frac{110\times10^3}{21^3} \end{aligned}$$

boat provides constant power from engine

$$P = Fv$$

$$F_{\text{engine,new}} = \frac{P}{v} = \frac{110\times10^3}{15}$$

$$\begin{aligned} F_{\text{new}} &= F_{\text{engine, new}} - kv_{\text{new}}^2 \\ &= \frac{110\times10^3}{15} - \left(\frac{110\times10^3}{21^3}\right)15^2 \\ &= 4660\ \text{N} \end{aligned}$$

14 surfaces in contact have same *linear* speed because no slipping, eliminate B and D

$$v = r\omega$$

$$R\Omega = r\omega$$

$$\Omega = \frac{r}{R}\omega$$

15 vertical circular motion that has PCE.

At top, weight and tension provides centripetal force:

$$W + \cancel{T}^{0} = \frac{mv_{\text{top}}^2}{r}$$

$$\frac{1}{2}mv_{\text{top}}^2 = \frac{1}{2}Wr = \frac{1}{2}(mg)r$$

Conserve energy:

$$\begin{aligned} \frac{1}{2}mv_{\text{bottom}}^2 &= \frac{1}{2}mv_{\text{top}}^2 + mgh \\ &= \frac{1}{2}mgr + mg(2r) \\ &= \frac{5}{2}mgr \end{aligned}$$

$$v = \sqrt{5gl}$$

16 gravitational force provides centripetal force

$$\begin{aligned} \cancel{m_{\text{Eu}}}\, r\omega^2 &= \frac{GM_{\text{Jupiter}}m_{\text{Eu}}}{r^2} \\ &= \cancel{m_{\text{Eu}}}\, r\left(\frac{2\pi}{T}\right)^2 \\ M_{\text{Jupiter}} &= \left(\frac{2\pi}{T}\right)^2\frac{r^3}{G} \\ &= \left(\frac{2\pi}{85\times60^2}\right)^2\frac{\left(6.7\times10^5\times10^3\right)^3}{6.67\times10^{-11}} \\ &= 1.90\times10^{27}\ \text{kg} \end{aligned}$$

17 at mid point, net force is zero.

18 gravitational force provides centripetal force

$\frac{GM_Em}{r^2} = \frac{mv^2}{r}$	$\frac{GM_E\cancel{m}}{r^2} = \cancel{m}r\omega^2$
$\frac{1}{2}mv^2 = \frac{1}{2}\frac{GM_Em}{r}$	$GM_E = r^3\omega^2$

need to compare energy

$$\begin{aligned} E_{\text{total}} &= \text{KE} + \text{GPE} \\ &= \frac{1}{2}mv^2 + \left(-\frac{GM_Em}{r}\right) \\ &= \frac{1}{2}\frac{GM_Em}{r} + \left(-\frac{GM_Em}{r}\right) \\ &= -\frac{1}{2}\frac{GM_Em}{r} \\ &\left[= -\text{KE} \quad \text{or} \quad \frac{1}{2}\text{GPE}\right] \end{aligned}$$

A: true. Sat_A is nearer so has less GPE so less total energy if the Sats have same mass. For Sat A to have same total energy, Sat_A is more massive.

C: true. Sat_B has larger *r* so smaller *ω*

D: *E*_total = − KE so same KE

19 Consider change in GPE

$$\Delta U = m\Delta\phi$$
$$= m\left(\phi_{\text{final}} - \phi_{\text{final}}\right)$$
$$= m\left(-\frac{GM_E}{R} - \left(-\frac{GM_E}{5R}\right)\right)$$
$$= -\frac{4}{5}\frac{GM_E m}{R} \qquad (\text{prove D false})$$

20 bouncing ball has constant acceleration of g = 9.81 m s^{-2} except during contact with ground, does not obey $a = -\omega^2 x$

21 Using $v = \pm\omega\sqrt{x_0^2 - x^2}$

$$30 = \pm\omega\sqrt{x_0^2 - 20^2}$$
$$20 = \pm\omega\sqrt{x_0^2 - 30^2}$$

solve simultaneous

$$\omega = 1$$
$$x_0^2 = 1300$$

$$v = \pm(1)\sqrt{1300 - 25^2}$$
$$= 25.9 \text{ mm s}^{-1}$$

22 By PCE, max PE = max KE

$$\text{KE}_{\text{max}} = \frac{1}{2}m\omega^2\left(x_0^2\right)$$

$$\text{PE} = \text{KE}_{\text{max}} - \text{KE}_{\text{anytime}}$$
$$= \frac{1}{2}m\omega^2\left(x_0^2\right) - \frac{1}{2}m\omega^2\left[x_0^2 - x^2\right]$$
$$= \left(\frac{1}{2}m\omega^2\right)x^2$$

$$4.1 = \frac{1}{2}m\omega^2 = \frac{1}{2}m\left(\frac{2\pi}{T}\right)^2$$
$$T^2 = \frac{4\pi^2 m}{2(4.1)}$$
$$T = \sqrt{\frac{4\pi^2(1.5)}{2(4.1)}} = 2.69 \text{ s}$$

23 reduce 30% means 70% transmitted

$$I = I_0 \cos^2\theta$$
$$\frac{I}{I_0} = 0.7 = \cos^2\theta$$
$$\theta_{\text{basic}} = 33°$$

24 $v = f\lambda \rightarrow \lambda = \dfrac{8000}{5000}$

$$\frac{\Delta\phi}{2\pi} = \frac{\Delta s}{\lambda}$$
$$\Delta\phi = 2\pi\left(\frac{2}{8/5}\right) = \frac{5}{2}\pi = \frac{\pi}{2}$$

25 Huygen's principle (see Annex - single slit)

26 Grating X produces the horizontal dots

$$d \sin\theta = n\lambda$$
$$\frac{1}{N}\left(\frac{\text{opposite}}{\text{hypotenuse}}\right) = n\lambda$$
$$N = \frac{1.6}{3\left(450\times10^{-9}\right)\sqrt{3.6^2 + 1.6^2}}$$
$$= 3\times10^5$$

27 for L_1, waves formed are integers of multiples of $\frac{\lambda}{2}$

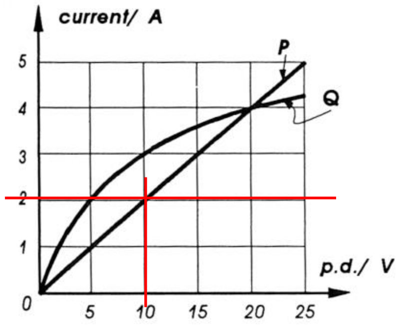
Let $L_1 = p\frac{\lambda}{2}$, p is integer

for L_2, waves formed are odd integers of $\frac{\lambda}{4}$

Let $L_2 = (2q+1)\frac{\lambda}{4}$, q is integer

$$\frac{L_2}{L_1} = \frac{(2q+1)\frac{\lambda}{4}}{p\frac{\lambda}{2}} = \frac{2q+1}{2p}$$

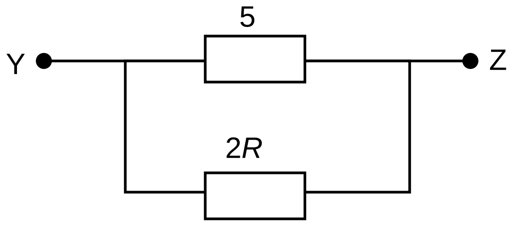
28 P and Q in series so same amount of current flowing through both of them

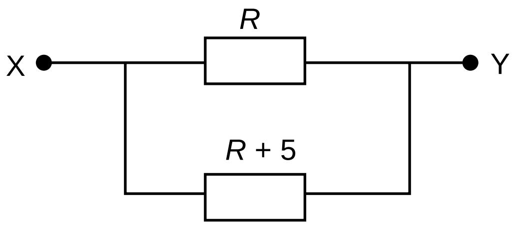


p.d. across Q is 5 V, total pd is 15

29 $I = \dfrac{Q}{t} = \dfrac{8Q}{T} = \dfrac{8Q}{2\pi / \omega} = \dfrac{4Q\omega}{\pi}$

30 Re-drawing:





$$R_{YZ} = \frac{10R}{5 + 2R} = 2.5\ \Omega$$

$$R = 2.5\ \Omega$$

$$R_{XY} = \frac{(2.5)(7.5)}{10} = 1.9\ \Omega$$