EUNOIA JUNIOR COLLEGE
JC1 PROMOTIONAL EXAMINATIONS 2019
General Certificate of Education Advanced Level
Higher 2

PHYSICS 9749

Multiple-Choice & Structured Questions
MARK SCHEME w/ EXAMINERS' COMMENTS
Maximum Mark

September / October 2019

Paper 1 Answer Key

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

Paper 2 Mark Scheme

1 **(a)** **(i)** Gradient of tangent (at t = 10 s) = (100-0)/(10-6) **M1**

$= 25 \text{ m s}^{-1}$ **A1**

(ii) By Principle of conservation of energy

Loss in E_p = Gain in E_k

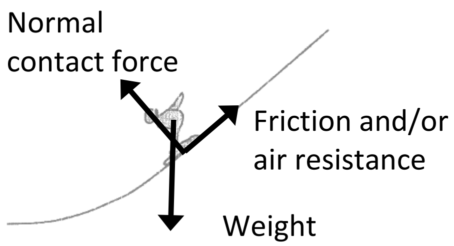
$(0.55)\,mgh = \frac{1}{2} mv^2$ **M1**

$(0.55)(9.81)h = \frac{1}{2}(25)^2$

$h = 57.9$

$= 58$ m (2 s.f) **A1**

(b) **(i)** All 3 forces (Normal Contact, Weight, Resistive Force) drawn and labelled correctly. **B1**



(ii) The resultant force acting on the skier is downwards and parallel along the slope. Hence the skier experienced an acceleration, resulting in an increased in speed. **B1** **B1**

This explains the increasing rate of change of distance with time shown in the graph.

(c) **(i)** $s = ut + (0.5)at^2$

$80 = (0.5)(9.81)(t^2)$

$t = 4.0$ s **A1**

(ii) $x = vt = 25(4.0) = 100$ m **A1**

Examiners' Comments

(a) (i) Many candidates incorrectly used $s = ½ (u + v)t$ to solve the problem. They cannot assume that the curve graph is parabolic and that the acceleration is constant. Some candidates incorrectly used the relationship *speed = total distance / total time* which gives the average speed. The tangent at t = 10 s were absent in many scripts. Working for the gradient of the tangent are often missing.

(ii) Presentations were often poor and lacking in the concept being used. Candidates should write down the physics concepts used and the required equations. Candidate often substituted numbers without the equation. Many candidates missed out or wrongly used the 55% value given in the question. They used 55% of the kinetic energy instead. Candidates should have checked their working again when they get small values of the ramp height.

(b) (i) Some candidates missed out the air resistance, friction, and normal contact force. Some of the weight and normal contact force were drawn in the wrong direction. Some wrongly drew the forward force. Some candidates did not label in full. Relative length of the arrows drawn is expected.

(ii) Many candidates failed to explain the presence and direction of the resultant force. Explanations were often vague and not coherent. Some used energy concepts to explain the graph which were not the required answers. They should use the idea of the resultant force to bring about the idea of acceleration which then lead to the increasing speed as shown in the graph.

(c) (i) Many candidates wrongly used $s = ½ (u + v)t$.

(ii) This part was done well by most.

2 (a) (i) Linear momentum is the product of mass and velocity. **B1**

(ii) The Principle of Conservation of Linear Momentum states that the total linear momentum of a system remains constant provided that no resultant external force acts on the system. **B1**

(b) (i) Total momentum in the horizontal direction = m v =(0.3) (8.0 cos 60°) **B1**

= 1.2 kg m s^{-1}

By conservation of momentum,

initial momentum = final momentum

$1.2 = m_x v_x + m_Y v_Y$ **M1**

$1.2 = (0.20)(-4) + (0.10)\, \boldsymbol{v_Y}$

$\boldsymbol{v_Y} = 20$ m s^{-1} **A0**

(ii) Impulse of Y = m ($v_f - v_i$) = (0.1)(20-4) **B1**

= 1.6 kg m s^{-1} **A1**

(iii)

$$F = \frac{\Delta p}{t}$$

$$= \frac{1.6}{0.001}$$ **M1**

$$= 1600 \text{ N}$$ **A1**

(c) At P:

Before the explosion, $E_k = ½ m v^2$ **M1**

$= ½ (0.30)(8.0 \cos 60°)^2$

= 2.4 J

After the explosion, $E_k = ½ m v_x^2 + ½ m v_y^2$

$= ½ (0.20)4^2 + ½ (0.1)(20)^2$ **M1**

= 1.6 + 20

= 21.6 J

Energy released in the explosion = 21.6 – 2.4

= 19.2 J **A1**

(d) Point P' is lower and closer to start point as compared to P. **B1**

Examiners' Comments

(a) In stating the Principle of Conservation of Momentum, candidates should not use the any form of the root word 'conserve'. That fails to demonstrate any understanding.

(b) A small proportion of candidates fail to realise that the horizontal velocity of the firework at the top of the projectile is 8 cos 60°, several took the horizontal speed at that point to be 8 m s^{-1}.

(c) Candidate are advised that the difference in kinetic energy should be found using ($½ mv^2$ - $½ mu^2$) rather than $½\, m(v\text{-}u)^2$. This issue cropped up mostly when there was an attempt to find the difference in kinetic energy of X and Y separately.

(d) Point P' was generally clearly indicated.

3 **(a)** **(i)**

$$R = \rho \frac{L}{A}$$

$$= \left(9.8 \times 10^{-7}\right) \times \frac{16}{0.20 \times 10^{-6}}$$ **M1**

$$= 78.4\ \Omega$$ **A1**

(ii)

$$P = I^2 R = \frac{V^2}{R}$$

$$= \frac{(240)^2}{78.4}$$ **M1**

= 734.7 W

= 735 W (3 s.f) **A1**

(b)

	switch A	switch B	switch C	
Lowest	**OFF**	**ON**	**OFF**	**A1**
Highest	**ON**	**OFF**	**ON**	**A1**

Examiners' Comments

Several candidates had problems with part (a) due to the conversion of mm^2 to m^2. For part (b), many candidates failed to realise that the maximum operating power occurs when there is minimum resistance (when the resistance are in parallel) and minimum operating power occurs when there is maximum resistance (when the resistance are in series).

4 **(a)** It is the <u>change of phase per unit time</u> of an oscillation. **B1**
OR <u>rate of change of phase</u> of the oscillating mass

(b) (i) **1.** 2.0 cm **A1**

2. 1.5 cm **A1**

(ii) reference to <u>displacement from *s* = 2.0 cm</u> **or** <u>equilibrium position is at *s* = 2.0 cm</u> **B1**

<u>straight line</u> indicates that <u>acceleration is directly proportional to displacement</u>. **B1**

<u>negative gradient</u> indicates that <u>acceleration and displacement are in opposite directions</u>. **B1**

(iii) **1.**

$$\omega^2 = -\frac{1}{\text{gradient}}$$

$$\omega^2 = -\frac{1}{\dfrac{0.035 - 0.005}{-0.9 + (-0.9)}}$$

$$\omega = \sqrt{60}$$

$$2\pi f = \sqrt{60}$$

$$f = 1.2 \text{ Hz}$$

$$a = -\omega^2 x$$ **C1**

$$-0.9 = -\omega^2 (0.015)$$

$$\omega = \sqrt{60}$$

Power of Ten (P.O.T.) errors are ignored **M1**

A1

2. $v_o = \omega x_o = \sqrt{60}(0.015) = 0.116 \text{ m s}^{-1}$ **(allow e.c.f.)** **A1**

(c)

$$\frac{E_{K(f)}}{E_{K(i)}} = \frac{3}{4}$$

$$\frac{\frac{1}{2} m\omega^2 {x_{o(f)}}^2}{\frac{1}{2} m\omega^2 {x_{o(i)}}^2} = \frac{3}{4}$$

$$\frac{x_{o(f)}}{0.015} = \sqrt{\frac{3}{4}}$$ **C1**

$x_{o(f)} = 0.013 \text{ m} = 1.3 \text{ cm}$ **(allow e.c.f.)** **A1**

Examiners' Comments

(a) A large number of candidates provided the definition of frequency instead of angular frequency as required.

(b) A large number of candidates were not able to answer (i)1 correctly. Those who were able did not seem to realize that that was the equilibrium position of the oscillations, which had an implication for their answers in part (ii); many candidates incorrectly stated that the graph passed through the origin, which was obviously incorrect. For part (iii), a large number of candidates made powers of ten (P.O.T.) errors in their substitutions.

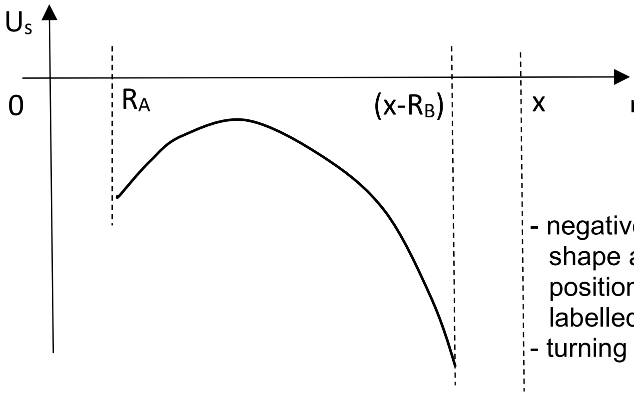
(c) Candidates are reminded that for questions involving comparison of 2 similar situations, calculations using the numerical ratio will normally suffice.

5. **(a)** **(i)** (i) $U_s = U_A + U_B$ **B1**

$= -\frac{Gm_A m_s}{r} + (-\frac{Gm_B m_s}{x-r})$

$= -Gm_s(\frac{m_A}{r} + \frac{m_B}{x-r})$

(ii)



- negative asymmetric shape and correct U positions. Appropriately labelled. **B1**
- turning point nearer to A **B1**

(iii) The gravitational force acting on the shuttle at a point r is given by the negative of the gradient of the tangent drawn at a point r on the U_s vs r graph. As the shuttle moves towards B, the negative of the gradient of the tangent decreases implying that the resultant gravitation force acting on the shuttle decreases and directed towards A. **B1**

At the turning point on the U_s vs r graph, the resultant gravitational force acting on the shuttle is zero. **B1**

As the shuttle moves from the point where the net force is zero nearer to B, the negative of the gradient of the tangent increase implying that the gravitation force acting on the shuttle increases and directed towards B. **B1**

OR

The negative of the gradient of the tangent drawn at point in the U_s vs r graph gives the gravitation force acting on the space shuttle. **B1**

As the space probe moves from towards planet B, the force is directed towards planet A and it decreases in magnitude. When U_s is maximum, the gravitational force acting on the shuttle is zero. **B1**

After the point where U_s is maximum, the force acting on the shuttle is directed towards planet B and increases in magnitude as it approaches planet B. **B1**

(b) **(i)** The gravitational force acting on S_1 due to the earth provides the centripetal force for it to complete the circular motion about the earth. **B1**

Using Newton's 2nd Law: $F_{net} = ma_c$ (where a_c is the centripetal acceleration)

$F = GMm/a^2 = m(v^2/a)$

B1

$mv^2 = GMm/a$

$E_k = ½\, mv^2 = ½\, GMm/a$ … [1]

$E_p = -\, GMm/a$ … [2]

$E_k/E_p = ½\, GMm/a \;\; / -GMm/a$

$= -\, ½$

$E_k = -1/2 \quad E_p$

(ii) $E_{total} = E_p + E_k = -GMm/2a$ **B1**

(iii) 1. At A, Total energy of S_1 = Total energy of S_2

$TE_{A1} = TE_{A2}$

$-GMm/2a = E_k + E_p$

$-GMm/2a = ½\,(2m)v^2 + (-GM(2m)/a)$ **M1**

$3/2\; GM/a = v^2$

$v = \sqrt{(3/2\; GM/a)}$ **A1**

2. By conservation of energy,

Total energy of S_1 = the total energy of S_2 at A = total enegy of S_2 at C

$TE_{A2} = TE_{C2}$

$-GMm/2a = E_k + E_p$

$-GMm/2a = ½\,(2m)\,v^2 + (-GM(2m)\,/\,(3/2)a)$ **M1**

$(\,4/3 - ½\,)\; GM/a = v^2$

$v = \sqrt{(5/6\; GM/a)}$ **A1**

Examiners' Comments

(a) **(i)** Some candidates wrongly used the difference in potential energies.

(ii) Poorly drawn and labelled. Many candidates could not tell which planet has a lower gravitational potential energy at the surface of the planet. Many candidates could not correctly determined the turning point.

(iii) Most candidates missed out mentioning that the gravitation force acting on the shuttle at a point is given by the negative gradient of the tangent drawn at that point in the U_s vs r graph. Most candidates missed out the direction of the gravitational force. Many candidates failed to link the gradient of the slope of the graph to the magnitude of the gravitational force.

(b) **(i)** Poorly presented by most candidates. Candidates were unable to sequence the proving steps correctly. Missing steps were common. The gravitational potential energy equation were often left out in their presentation. Some "$F_G = F_C$" were often seen with defining the terms. Gravitational force = Centripetal force is an incorrect expression. Some candidates did not prove the kinetic energy equation.

(ii) Mostly well done. Some missed out the negative sign. Some used r instead of a.

(iii) Poorly done by most candidates. Many candidates failed to take into account the mass of S_2.

6 **(a)** **(i)** $\text{weight} = 16 \times 1000 \times 9.81$

$= 1.57 \times 10^5 \text{ N (or kg m s}^{-2}\text{)}$

numerical value – **A1**
appropriate unit – **A1**

(ii) Since the total length of the jib and counter jib is 55.0 m and distance x is 22.3 m, the <u>largest possible value for y is 32.7 m</u>. **B1**

(b) **(i)** Taking moments about the centreline of the tower:

Anti-clockwise moment provided by the balancing load

$= (1.57 \times 10^5)(17.3) = 2.72 \times 10^6 \text{ Nm}$

Clockwise moment provided by the maximum load at y = 30 m

$= (8.48 \times 1000 \times 9.81)(30) = 2.50 \times 10^6 \text{ Nm}$

B1

OR

Net anti-clockwise moment provided by maximum load at y = 30 m

$= (1.57 \times 10^5)(17.3) - (8.48 \times 1000 \times 9.81)(30) = 2.20 \times 10^5 \text{ Nm}$

Clockwise moment provided by the maximum load at y = 52 m

$= (4.31 \times 1000 \times 9.81)(52) = 2.20 \times 10^6 \text{ Nm}$

Clockwise moment provided by the maximum load at y = 75 m

$= (2.60 \times 1000 \times 9.81)(75) = 1.91 \times 10^6 \text{ Nm}$

M1

OR

Net anti-clockwise moment provided by maximum load at y = 52 m

$= (1.57 \times 10^5)(17.3) - (4.31 \times 1000 \times 9.81)(52) = 5.17 \times 10^5 \text{ Nm}$

Net anti-clockwise moment provided by maximum load at y = 75 m

$= (1.57 \times 10^5)(17.3) - (4.31 \times 1000 \times 9.81)(52) = 8.03 \times 10^5 \text{ Nm}$

B1

Since the <u>anti-clockwise moment</u> provided by the balancing load <u>is always greater than</u> / <u>is never equal to</u> the <u>clockwise moment</u> provided by the maximum load, **A1**
the two can never put the crane in equilibrium.

(ii) At the connection between the tower and the jib and counter jib, the <u>tower exerts a couple</u> on the jib and counter jib. **B1**
This <u>provides the additional clockwise moment</u> needed to keep the jib and counter jib in equilibrium. **B1**

Examiners' Comments

(a) It was disappointing to see a significant number of candidates getting part (i) incorrect, with the majority giving the mass of the counter-balance instead or using g = 10 m s^{-2}. Candidates should take note to evaluate all necessary numerical values that support their arguments rather than to simply state values that are already given and expect the examiners to come to the conclusion or make the deduction for them.

(b) **(i)** A large number of candidates did not use the correct expression to determine the moment of the forces involved or did not fully evaluate all necessary numerical values to support their arguments. Some candidates started by equating clockwise moments to anti-clockwise moments even though from the question, it is expected that they will not be equal.

(ii) This part was poorly done; many candidates stated that the weight of the jib or counter-jib will provide the additional moment required to keep the crane in equilibrium without realizing that this value is fixed while the moment due to the load varies as its distance to the centerline varies when the crane is in use.

7 **(a)** Two waves with a constant phase difference. **B1**

(b) **(i)** Since the two waves are produced in phase and have zero path difference at point A, constructive interference happens at A. **B1**

$A_A = A_1 + A_2$

$I_A = kA_A{}^2$

$= k\left(\sqrt{\frac{I}{K}} + \sqrt{\frac{4I}{K}}\right)^2$ **M1**

$= 9I$ **A1**

(ii) Path difference

$\Delta x = 4.02 - 3.72 = 0.3\text{ m}$

$= 2.5\,\lambda$

$\lambda = \frac{v}{f} = \frac{336}{2800} = 0.120\text{ m}$

Since the path difference is exactly 2.5 wavelengths, the 2 waves arrive out of phase resulting in destructive interference.

Since the sources are in phase (evident from the maxima at N) and the path difference to P = S2P – S1P
= 402 – 372 = 30 cm **B1**

Hence, the phase difference of the waves meeting at P is 5π, the waves meet in antiphase at P and destructive interference occurs. **M1**

So a minimum signal is detected at B. **A1**

(iii) When the frequency of the wave from the oscillator is increased, its wavelength decreases. Thus (although the path difference between S_1B and S_2B remains unchanged) the phase difference of the waves arriving at B changes. **M1**

When the waves meet in phase and constructive interference occurs and a maximum intensity is detected.
When the waves meet in antiphase and destructive interference occurs and a minimum intensity is detected. **M1**

Hence a series of loud and soft sound will be heard. **A1**

(c) **(i)** Using the geometry of the first order bright dot to calculate,

$$\tan\theta = \frac{107.3 - 72.7}{200}$$ **C1**

$$\theta = 9.82^\circ$$

Using the equation for diffraction grating,

$d\sin\theta = n\lambda$ where n = 1

$$\lambda = \frac{1\times10^{-3}}{250}\sin(9.82)$$ **M1**

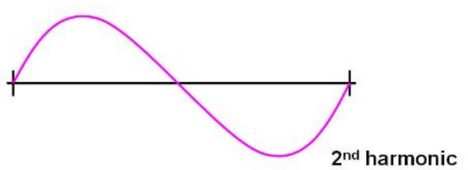
$$= 682\ \text{nm}$$ **A1**

(ii) Instead of a localized bright maxima, an extended maxima fringe of some width is observed. (due to each wavelength diffracting by a slightly different angle) **B1**

(iii) Blue light has a shorter wavelength than red light. **B1**

Maxima is closer together or more fringes being visible. **B1**

(d)



$L = \lambda_1$ **C1**

The next mode of vibration that fulfils the criteria is:

$L = 3\lambda_2$ **C1**

$v = f_1 L$

$v = f_2 \dfrac{L}{3}$ **M1**

$\therefore f_1 = \dfrac{f_2}{3}$

$f_2 = 300$ Hz **A1**

Examiners' Comments

(a) A common mistake seen across the scripts was stating that the two waves have the same phase difference; this is not the same as when two waves have constant phase difference.

(b) (i) A common issue is the failure by candidates to give complete reason why waves interfere constructively at A. A number of candidates stated that path difference from S_1 and S_2 is zero at A, without mentioning that S_1 and S_2 are in phase. Applying the relationship I proportional to A^2 incorrectly (i.e. $A = I^{½}$ without including the constant of proportionality). A number of candidates also incorrectly stated that the sum of intensity is $4I + I$.

(ii) Similarly for this question, candidates who failed to score all marks did not mention that S_1 and S_2 are in phase or incorrectly stated that the phase difference of 5π is due to sum of phase difference at source and at P.

(iii) Incomplete answers included the failure to explain that
- when wavelength decreases, the phase difference changed, or
- phase difference that are odd integer multiples of π of results in waves meeting out of phase and hence destructive interference while those of even integer multiples of π results in waves meeting in phase and hence constructive interference, or
- a continuous change in phase difference to a series of loud of soft sound detected.

(c) (i) Common mistakes include inability to find tan θ, or approximating sin θ to tan θ. Another glaring mistake is applying the formula for Young's double slit experiment instead for the formula for multiple slits diffraction grating.

(ii) Vague answers include a spectrum of red lights observed. Answers accepted, besides the suggested solution, would include a spectrum of red lights observed for each order of diffraction.

(d) Candidates who were unable to get this correct failed to understand that resonance occurs when Q which is ¼ of L is at maximum. Some others also did not take into account that L is fixed. And that the two ends of the string are fixed (nodes).