2018 SINGAPORE-CAMBRIDGE A LEVEL H2 PHYSICS P1 SUGGESTED ANSWER KEY (9749)

Written and Prepared by Mr Mitch Peh

Preface

Dear JC students in Singapore,
Hope you will find this A Level examination solution set useful for your revision.

The answers and comments to this solution set are personally crafted and written by Mr Mitch Peh, an experienced former MOE JC lecturer and tutor in Singapore. Currently, Mr Peh is a full time A Level private tutor, specialising in the teaching of A Level subjects: Physics, Chemistry, Mathematics and Economics at both H1 and H2 Levels. You can find the A Level solutions for the other subjects under the various subject tabs at www.jcpcme.com.

Mr Peh has a proven track record in helping his students achieve success for the A Levels and internal school examinations including promos, advancement tests to JC2, block tests, mid years and prelims. Most of Mr Peh's students achieve "A's and 'B's grades for the A Level examinations. During his stint teaching at St Andrew's Junior College, Mr Peh has helped his classes achieve 100% promotion to JC2 on multiple occasions, attain close to 100% "A"s for H1 Project Work, clinch accolades like "Most Improved Class Award" and "Best Performing Class of the Cohort" for many of the internal school examinations. Mr Peh also has former students who subsequently went on to pursue H3 subjects and enroll in prestigious university courses like Dentistry, Medicine and Law.

If you are interested to be coached by Mr Peh for your preparations towards the A Levels, these are 3 more reasons why you should join Mr Peh's classes:

1. **Lessons can be fully customised to your needs**
- You have the full autonomy to decide the subject(s), content and pace that you want to cover for each lesson, out of any of the 4 subjects: Physics, Chemistry, Mathematics or Economics.
- Mr Peh will help to analyse your weaknesses in each individual subject and provide personalised feedback and suggestions for improvement.

2. **Answers to your questions can be addressed outside of the classroom**
- If you face any difficulty or challenge doing any of your tutorial questions, simply take a screenshot with your phone and send it to Mr Peh via Whatsapp. Mr Peh will answer your questions in the earliest possible time when he is available.

3. **You only pay the price of 1 subject but enjoy premium coverage for all 4 subjects**.
- Mr Peh provides resources for all 4 subjects including summarised notes, compiled topical questions sourced from past year school prelim examinations, Practical guides for Chemistry & Physics, examination checklists, mock papers etc.
- This is probably the only tuition service in Singapore which allows you to enjoy such extensive coverage and benefits.

Note that Mr Peh only takes in a limited number of students each year. You can find his lesson slots available under "Tuition Services" tab at www.jcpcme.com. For any further enquiries, you can directly whatsapp him at 9651 7737.

For the solution set below, if you find any discrepancies or you have any feedback or comments, please kindly direct them to Mr Peh through Whatsapp at 9651 7737.

The question paper has been omitted due to copyright reasons.

2018 A Level H2 Physics P1 Suggested Answer Key (9749)

30 marks, 15% weightage

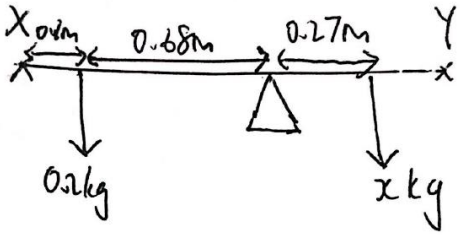
1	**A**	6	**A**	11	**C**	16	**C**	21	**A**	26	**A**
2	**A**	7	**C**	12	**D**	17	**A**	22	**A**	27	**C**
3	**B**	8	**B**	13	**D**	18	**C**	23	**D**	28	**A**
4	**C**	9	**D**	14	**C**	19	**C**	24	**A**	29	**C**
5	**A**	10	**A**	15	**D**	20	**A**	25	**A**	30	**B**

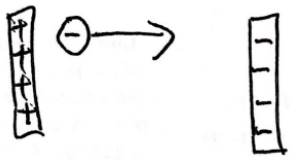
Analysis of 2018 A Level Physics Paper 1 (9749)

- Relatively manageable paper where you should double check your answers, to ensure that you are using the right approach and avoid making careless and silly mistakes for the questions.
- As usual, there are some difficult and time consuming questions in this paper. Under examination conditions, I would strongly encourage students to just move on first if you are stuck halfway through, and secure your marks for the remaining questions. Always remember that you should be maximising the amount of marks that you can get for the paper.
- The usual types of calculation questions are being tested in this paper. You are also strongly encouraged to be familiar with the ratio method as it can make your manipulations simpler and faster.
  - Principle of conservation of momentum: Q4
  - Principle of moments: Q5, Q4
  - Considering free body diagram equation: Q6, Q7 and Q10
  - Ratio method: Q7, Q17 and Q30
- Graphical analysis questions have also appeared in this paper: Q12, Q15
- The difficult questions in this paper are the following:
  - Q18 on stationary waves. This question can be a little time consuming as well to arrive at the correct option.
  - Q24 on electromagnetism and forces on the concept of moments. This is a hybrid question where some students have difficulties synthesising the knowledge from the 2 topics together to solve the question. Also, we need to remember to account for the value N in our calculations to get the correct answer. In addition, we have to be strong in trigonometric manipulations to resolve the question.
- For A Level Physics MCQ papers, it is strongly advisable to practise past year A Level MCQ Papers as there is usually a few repeat questions in the paper. You can possibly save some time working through these questions in the actual examination if you have done them previously before already. The following are the repeat questions in this year's paper:
  - Q6 is a repeat of 2015 A Level P1/Q6 on the topic of forces.
  - Q20 is a repeat of 2007 A Level P1 Q25 on the topic of electric field.

Detailed Solutions

Qn	Ans	Detailed Explanations
1	A	Topic: Measurement on uncertainty $T = 2\pi\sqrt{\frac{L}{g}} \Rightarrow T^2 = 4\pi^2\left(\frac{L}{g}\right)$ $g = \frac{4\pi^2 L}{T^2}$ $\frac{\Delta g}{g} = \frac{\Delta L}{L} + 2\left(\frac{\Delta T}{T}\right)$ $\frac{0.05}{6.25} + 2\left(\frac{\Delta T}{T}\right) \le 0.02$ $\frac{\Delta T}{T} \le 0.006$ Hence, maximum percentage uncertainty in T is 0.6%. Comments • We have to make g the subject in this question first.
2	A	• Topic: Kinematics • Distance travelled is the summation of the area under the graphs while displacement specifically for Q is the area above x axis minus area below x axis. • Hence, displacement for object P is greater than the displacement for object Q. • As for the distance travelled by each object, Distance travelled by P is $0.5vt_1 + 0.5v(t_2-t_1)=0.5vt_2$ Distance travelled by Q is $(0.5)(0.5v)(0.5t_1)(2)+(0.5)(0.5v)(0.5)(t_2-t_1)(2)$ $=0.25vt_1+0.25v(t_2-t_1)$ $=0.25vt_2$ Hence, the distance travelled by P and Q are different. Comments • A common error that students will make is to choose option B, thinking the distance travelled is the same. • However, this can be verified with the calculations shown above.
3	B	Topic: Dynamics on the concept of impulse Impulse = change in momentum $= m\Delta v$ = (0.080)(18+23)=3.3Ns Comments • Simple calculation based on the understanding of the concept of impulse • Using the correct units and ensuring that the signs you have used are correct are important to avoid careless mistakes for this question.

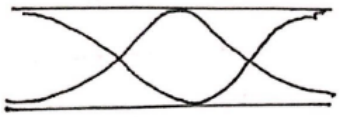
Qn	Ans	Detailed Explanations
4	C	Topic: Dynamics on principle of conservation of momentum • Taking rightwards as positive, • Magnitude of total initial momentum $= m_1u_1 + m_2u_2 = (5.0)(4.0) + (2.0)(-3.0) = 14Ns$ • By Principle of conservation of momentum, $14 = (m_1 + m_2)v$ 14=7v v =2.0ms^{-1}(to the right) Comments • Simple and straight forward calculation based on principle of conservation of momentum
5	A	• Topic: Forces on the concept of moments • Initially, for the broom to be balanced, the net moment must be 0. Hence, the centre of mass of the broom needs to be at O. • Let the mass of the broom be x g. • Taking pivot about the top of the chair after 200g mass is tied to the handle of the broom and moving 0.27m to the right,  • Total anticlockwise moment = Total clockwise moment (200g)(0.95-0.27) = (x)(g)(0.27) x=503g = 500g approximately. Comments • We have to read the question carefully that the 200g is tied to the handle by a thread at a distance of 0.10m from the end of X and not at end of X itself. Otherwise we will obtain the incorrect answer of option B as 580g.
6	A	• Topic: Forces on the concept of upthrust and free body diagram • When the barge is above the bridge, it displaces water. • From the principle of floatation, the weight of the barge must be equal to the upthrust acting on the barge. • From Archimedes principle, upthrust is equal to the weight of water which has been displaced. • Hence, the weight of the barge is equal to the weight of the water displaced. • The bridge will have to support the additional weight of the barge but need not support the weight of the water displaced anymore. • Hence, overall there is no extra weight supported by the bridge.

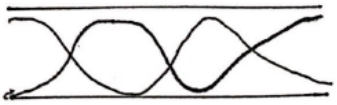
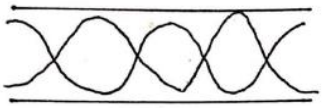
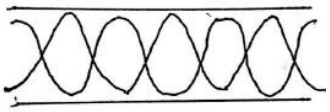
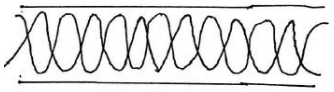
Qn	Ans	Detailed Explanations
6		Comments • Repeat of 2015 A Level P1/Q6
7	C	• Topic: Work, energy and power • Since the car is travelling at constant speed, F_{net} =0 so driving force = resistive force acting on the car i.e. $F=kv^2$ • Applying P= Fv formula and ratio method, $\frac{P_2}{P_1}=\frac{F_2v_2}{F_1v_1}=\frac{v_2^{\ 3}}{v_1^{\ 3}}$ $P_2=\left(\frac{40}{20}\right)^3\times 23=184kW$ Comments • Using ratio method to get the answer is more efficient as we need not bother about calculating the value of constant k, which will be cancelled out during the calculation.
8	B	• Topic: Work, Energy and Power • Gravitational potential energy is lower at S. Hence, answer can only be option B or D. • For electric potential energy of the electron, it is higher near the lower potential point. Hence, electric potential energy at S should be higher. Comments • Many students, even some of the better students, have problems determining whether electric potential energy at S is lower or higher. • One way to find out is to recall and consider the scenario of electrons moving between 2 parallel electric plates placed parallel to one another.  • When the electron is moved nearer to the lower potential plate, it will lose kinetic energy due to repulsive forces present and gain electric potential energy. • Hence, from this example, we will realise that electric potential energy of the electron is higher near the point of lower electric potential.

Qn	Ans	Detailed Explanations
9	D	• Topic: Circular Motion • Angular velocity refers to $\omega = \frac{2\pi}{T}$. Since the period is the same for both points P and Q, they will have the same angular velocity after a quarter of a revolution. • After a quarter of a revolution, both points P and Q will have the same angular displacement of $\frac{\pi}{2}$ or 90^0. <u>Comments</u> • Some students may not be familiar with the terms angular velocity and angular displacement. • Angular velocity simply means the angle travelled per unit time. • Angular displacement simply means the total angle travelled in the time period.
10	A	• Topic: Circular Motion • When the stone is vertically above the centre of the circle, both tension and weight are acting downwards • Hence, based on free body diagram, T+W= $Mr\omega^2$ Thus, T = $Mr\omega^2$-W <u>Comments</u> • Students who make mistakes for this question usually do so because they did not consider to write down the equation based on the free body diagram.
11	C	• Topic: Gravitation • Most students will know that path A and B are possible without the rocket firing its rocket. • Path D is possible as well when the spacecraft travelling away from Earth suddenly switches off its engine. This will cause the spacecraft to experience a deceleration, thus slowing down but still moving away from Earth. • In contrast, the tangential path of path C is completely not possible unless the spacecraft fires it engine. <u>Comments</u> • A thinking question where you have to consider the scenarios which will make each path possible.

Qn	Ans	Detailed Explanations
12	D	• Topic: Ideal Gas • Given pV=nRT, we would then want to make 1/p the subject of the equation to know the value of the gradient of the graph. $\frac{1}{p}=\frac{V}{nRT}$ • Hence, the gradient of the graph is $\frac{1}{nRT}$ • When amount of gas and thermodynamic temperature is doubled, the gradient will become ¼ of the original value. • Thus, the graph should be option D. Comments • A typical graphical analysis question
13	D	• Topic: Thermal Physics • Heat is transferred from a region of higher temperature to a region of lower temperature. • Since more heat is transferred into X, X should be below 30^0C. • Since more heat is transferred out of Z, Z should be above 30^0C. Comments • A question that is testing basic knowledge that you have already acquired in Secondary School where heat is always being transferred from a region of higher temperature to a region of lower temperature.
14	C	• Topic: Thermal Physics • Applying first law of thermodynamics, For process 1, $\Delta U = Q + W = 2800 - 600 = 2200kJ$ For process 2, $\Delta U = -2200kJ$ Hence, $-2200 = 1000 + W \Rightarrow W = -3200kJ$ Thus, the work done by system is 3200kJ. Comments • Straight forward calculation question where you need to be very clear what each variable in the equation of first law of thermodynamics means.
15	D	• Topic: Oscillation • Option A is incorrect as the amplitude of the oscillation should be 35cm instead. • Option B is incorrect and Option D is correct as KE is max at t=T/4. This is because the gradient of the distance-time graph is the steepest which means that speed is the highest for the oscillatory motion. At this position, the body is considered to be at the equilibrium position. • Option C is not true as the magnitude of the restoring force decreases between the time period stated since the object is returning back to the equilibrium position. • This can be shown by the formulae F=ma and $a = -\omega^2 x$. Hence, when the magnitude of x decreases, acceleration and restoring force both decrease.

<table>
<tr><th>Qn</th><th>Ans</th><th>Detailed Explanations</th></tr>
<tr><td>15</td><td></td><td><u>Comments</u>
Graphical analysis skills is required here.</td></tr>
<tr><td>16</td><td>C</td><td>• Topic: Waves
• Given v=fλ, when frequency of X is double of Y, its wavelength should be <u>half</u> of Y so that both waves have the same speed.
• Since I α A^2, when amplitude of wave X is twice the amplitude of wave Y, the intensity should be <u>4 times</u> compared to wave Y.

<u>Comments</u>
• This question requires students to recall the basic relationships between wavelength and frequency, between intensity and amplitude.</td></tr>
<tr><td>17</td><td>A</td><td>• Topic: Superposition
• Given that the distance from the centre of the pattern to the centre of the first dark region is 1.2mm, the original fringe separation is 2.4mm.
• Applying Young's double slit formula, $x = \frac{\lambda D}{a}$, and ratio method, given that a and D are kept constant,
$\frac{x_2}{x_1} = \frac{\lambda_2}{\lambda_1} \Rightarrow x_2 = \frac{600}{450} \times 2.4 = 3.2mm$
<u>Comments</u>
• We can use ratio method to get the answer quickly here.
• We have to be careful that 1.2mm does not represent the original fringe separation.</td></tr>
<tr><td>18</td><td>C</td><td>• Topic: Stationary Wave
• Recall that we need to have displacement antinodes at both open ends.
• When frequency increases, wavelength will become shorter, allowing more waves to be formed in the fixed length of the tube.
• For the initial node to be at 0.17m, 0.68m must correspond to 1 wavelength.
• Original frequency = $\frac{v}{\lambda} = \frac{340}{0.68} = 500Hz$
• To know the positions of the nodes, we can consider each wave to have 4 parts to it.
<table><tr><th>Frequency and stationary wave pattern in tube</th><th>Positions of nodes from right end of the tube</th></tr><tr><td>500 Hz,1 wave in tube
  </td><td>$\frac{0.68}{4} = 0.17m$, $\frac{0.68}{4} \times 3 = 0.51m$
Hence, node occurs at 0.17m</td></tr></table></td></tr>
</table>

<table>
<tr><th>Qn</th><th>Ans</th><th>Detailed Explanations</th></tr>
<tr><td>18</td><td></td><td>
<table>
<tr><th>Frequency and stationary wave pattern in tube</th><th>Positions of nodes from right end of the tube</th></tr>
<tr><td>750 Hz,1.5 wave in tube
  </td><td>$\frac{0.68}{6}=0.113m$, $\frac{0.68}{6}\times 3=0.34m$, $\frac{0.68}{6}\times 5=0.567m$
Hence, node does not occur at 0.17m</td></tr>
<tr><td>1000 Hz, 2 waves in tube
  </td><td>$\frac{0.68}{8}=0.085m$, $\frac{0.68}{8}\times 3=0.255m$,…
Hence, node does not occur at 0.17m</td></tr>
<tr><td>1500 Hz, 3 waves in tube
  </td><td>$\frac{0.68}{12}=0.0567m$, $\frac{0.68}{12}\times 3=0.17m$,…
Hence, node occurs at 0.17m</td></tr>
<tr><td>3000 Hz, 6 waves in tube
  </td><td>$\frac{0.68}{24}=0.0283m$, $\frac{0.68}{24}\times 3=0.085m$,
$\frac{0.68}{24}\times 5=0.142m$,
$\frac{0.68}{24}\times 7=0.198m$,….
Hence, node does not occur at 0.17m</td></tr>
</table>
<u>Comments</u>
• I would consider this as the most difficult question in this paper.
• In general, the stationary wave questions of the A Levels are tough so you have difficulties figuring out the answer, I would strongly advise you to just move on so that you have sufficient time to complete the rest of the MCQ paper.
</td></tr>
<tr><td>19</td><td>C</td><td>
• Topic: Electric Field
• The definition of electric field strength is force per unit positive charge.

<u>Comments</u>
• Students who choose option B or option D show confusion between the force experienced by a charge placed in a magnetic field versus electric field.
• For a charge to experience a force in an electric field, it can be placed stationary, or moving in any direction within the electric field.
• For a charge to experience a force in a magnetic field, it must have a component of velocity which is normal to the field.
</td></tr>
<tr><td>20</td><td>A</td><td>
• Topic: Electric Field
• Electric field strength is the negative electric potential gradient.
• Moving from left to right of the diagram, the electric potential is falling. Hence, electric field strength will be positive.
</td></tr>
</table>

Qn	Ans	Detailed Explanations
20		• Given that $E = \frac{\Delta V}{\Delta r}$ and ΔV between any 2 adjacent electric equipotential lines is constant at 100V, the magnitude of electric field strength decreases when the distance between equipotential lines increases. • Since the distance between equipotential lines is the longest from +100V to 0V and from 0V and -100V, the electric field strength will be the weakest at around 0V. <u>Comments</u> • Repeat of 2007 A Level P1 Q25. Many schools have also placed this question as an example question in their lecture notes so you should able to get this question correct.
21	A	Topic: Current and Electricity Applying the formulae $P = I^2R$ and $R = \frac{\rho l}{A}$, $P = I^2R = \left(40\times10^{-3}\right)^2 \frac{\rho\times1.8\times10^{-2}}{\left(1.2\times10^{-3}\right)\left(1.5\times10^{-2}\right)}$ $\rho = \frac{\left(400\times10^{-3}\right)\left(1.2\times10^{-3}\right)\left(1.5\times10^{-2}\right)}{\left(1.8\times10^{-2}\right)\left(40\times10^{-3}\right)^2} = 0.25\Omega m$ <u>Comments</u> • You will need to identify the correct cross sectional area when applying the formula of $R = \frac{\rho l}{A}$ • Also, be careful when keying in the values into your calculator.
22	A	• Topic: DC circuit • E.m.f = (1.5)(3)= 4.5V • Effective internal resistance = $\left(\frac{1}{0.6}+\frac{1}{0.6}\right)^{-1} = 0.3\Omega$ <u>Comments</u> • Note that we cannot add the e.m.f of the top part of the parallel circuit and the bottom part of the parallel circuit together to get 9.0V.
23	D	• Topics: Current and electricity, DC Circuit Since we are provided with the e.m.f value (6.0V) and total current in the circuit (0.50A), we can calculate the total effective resistance of the circuit. • $I_{total} = \frac{V_{total}}{R_{total}} \Rightarrow R_{total} = \frac{6.0}{0.50} = 12\Omega$ • Another way of finding the total effective resistance = $\left(\frac{1}{6}+\frac{1}{R}\right)^{-1}+10$

Qn	Ans	Detailed Explanations
23		$\therefore \left(\frac{1}{6}+\frac{1}{R}\right)^{-1}+10=12$ $\frac{1}{6}+\frac{1}{R}=\frac{1}{2} \Rightarrow R=3.0\Omega$ Since the p.d. across the top and bottom circuit must be the same, $(6.0)(0.50-I)=(3.0)(I)$ $3-6I=3I \Rightarrow I=0.33A$ Comments • This question requires some problem solving skills on the spot. • By just finding the value of resistance R, we would already know the answer is option D already since there is only one option with R= 3.0Ω.
24	A	• Topic: Electromagnetism, forces on concept of moments • Applying Fleming's left hand rule, the current is flowing through the section of the coil experiencing the magnetic field into the paper • To find the value of the magnetic force, F, we can calculate using the moments method. • Taking pivot about the top of the coil, The magnetic force contributes to clockwise moments while the weight contributes to anticlockwise moments • Hence, for clockwise moments = anticlockwise moments $(F)(L\cos 30^0) = (0.12)(0.5L\sin 30^0)$ F=0.034641N $B=\frac{F}{NIL}=\frac{0.034641}{(50)(0.40)(60\times10^{-3})}=0.029T$ Comments • This is a hybrid question where some students have difficulties synthesising the knowledge from the 2 topics together to solve the question. • We need to remember to account for N in our calculation. This can be a common error made by students. Otherwise, we will obtain the answer D instead.
25	A	• Topic: Electromagnetic Induction • The magnitude Induced e.m.f should be greater when the magnet is exiting the coil because the rate of change of magnetic flux is greater. This is because the speed of the magnet has become higher due to the acceleration of free fall. • Also, there is a change in the direction of the induced e.m.f because initially a south pole is induced at the top of the coil when the magnet is entering the coil. Then a south pole is induced at the bottom of the coil when the magnet is exiting the coil. • This is done to according to Len's law to oppose the change in magnetic flux linkage. Comments • Very manageable question as you should have come across similar voltage against time graph before in practice questions.

Qn	Ans	Detailed Explanations
26	A	• Topic: Electromagnetism • Referring to the formula list provided, magnetic flux density in a solenoid is given by $\mu_0 nI$. • Since the solenoids are connected in series to a power supply, the current flowing through both solenoids is the same. • Hence, the number of turns of wire on P should be the same as that on Q to obtain the same magnitude for magnetic flux density. • Then, the magnetic flux will cancel each other out completely to yield net magnetic flux density of 0. <u>Comments</u> • You will need to know that the radius of the coils do not affect the magnetic flux density generated inside the solenoid as well based on the formula $B = \mu_0 nI$.
27	C	• Topic: Alternating Current Since the current is half-wave rectified, I_{rms}= 3.8A $P_{ave} = I_{rms}^2 R = (3.8)^2 (9.4) = 140W$ <u>Comments</u> • We will need to know the relationship between peak current and root mean square current for half –wave rectification in this question.
28	A	• Topic: Quantum Physics on electron energy levels • To calculate the energy of a laser light photon, $E = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34})(3\times10^{8})}{633\times10^{-9}} = 3.1421\times10^{-19} J = 1.96eV$ • Hence, the corresponding transition for the electron is from W to X as 20.66 – 18.70 = 1.96eV as well. <u>Comments</u> • The difference in the energy level for the electrons is equal to the energy of a laser light photon based on conservation of energy where the loss in energy of the electron is converted into the energy of the photon.
29	C	• Topic: Nuclear Physics • Straightforward question where the top number represents the nucleon number and the bottom number represents the proton number. • Number of nucleons for X = 4+5 = 9 • Number of protons for X= 4

Qn	Ans	Detailed Explanations
30	B	Topic: Nuclear Physics on radioactive decay Applying and combining the formulae $A = \lambda N$ and $\lambda = \frac{\ln 2}{t_{0.5}}$, $A = \frac{\ln 2}{t_{0.5}} N \Rightarrow t_{0.5} = \frac{N \ln 2}{A}$ Hence, applying ratio method and substituting in the given values provided by the table, $\frac{\text{half-life of X}}{\text{half-life of Y}} = \frac{N_X A_Y}{N_Y A_X} = \frac{(4)(4.60\times10^7)}{(2)(3.68\times10^8)} = 0.25$ Comments • Manageable calculation question where ratio method will make the calculation simpler.

End of Solutions