HKDSE Physics & Combined Science (Physics)

Report on Assessment

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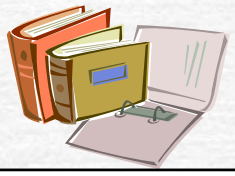

14 & 19 Sep 2012

1

Overview

Paper	Physics	CS(Phy)
1A (MC)	Mean : 21 out of 36 (i.e. 58%)	Mean : 11 out of 24 (i.e. 49%)
1B	~>55%	~45%
2	~<50%	N.A.
SBA	~>70%	~70%
Candidature	15 387	3 889

2

Marking & Grading

On-screen marking (OSM) panels	
Physics	**CS(Phy)**
1B-1: Q.1, 4, 5, 6 1B-2: Q.7, 8, 9, 10 1B-3: Q.2, 3, 11	1B-1: Q.1, 2, 3, 4 1B-2: Q.5, 6, 7, 8

2A: Astronomy (28%) 2B: Atomic World (63%) 2C: Energy (80%) 2D: Medical Physics (29%)	---

SBA marks stat. moderated with both Mean and SD adjusted (outlining cases reviewed by Supervisors)

3

Marking & Grading

- Expert Panel (Chief Examiners, 5 ~ 6 persons) determine level boundaries/cut scores based on
  1. Level descriptors
  2. Group Ability Indicator (GAI)
  3. Viewing student samples
- CS(Phy) graded by common items and viewing student samples
- Endorsement by Senior Management/Exam Board

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Results

Physics

Level	5+	4+	3+	2+	1+
Percentage	23.8%	48.6%	72.8%	88.7%	96.9%

CS(Phy)

Level	5+	4+	3+	2+	1+
Percentage	12.2%	28.7%	51.3%	74.6%	91.9%

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Paper 1A

Physics (36 MC)

>70%	50%-70%	<50%
7	18	11

Easy ⟷ Difficult

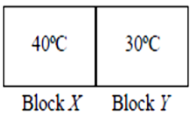
CS (Phy) (24 MC)

>70%	50%-70%	<50%
2	7	15

Easy ⟷ Difficult

6

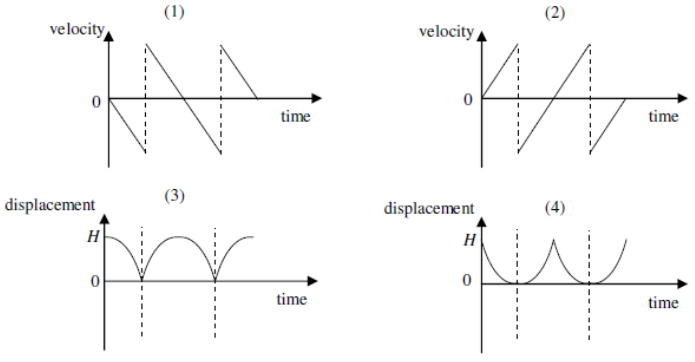
1. Two metal blocks X and Y of the same mass and of initial temperatures 40°C and 30°C respectively are in good thermal contact as shown. The specific heat capacity of X is greater than that of Y. Which statement is correct when a steady state is reached ? Assume no heat loss to the surroundings.



		Phy	CS(Phy)
A.	The temperature of block X is higher than that of block Y.	(5%)	(10%)
B.	Their temperature becomes the same and is lower than 35°C.	(12%)	(13%)
* C.	Their temperature becomes the same and is higher than 35°C.	(63%)	(48%)
D.	Their temperature becomes the same and is equal to 35°C.	(20%)	(29%)

7

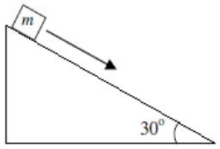
7. Which of the following graphs (velocity-time and displacement-time) best represent the motion of a ball falling from rest under gravity at a height H and bouncing back from the ground two times ? Assume that the collision with the ground is perfectly elastic and neglect air resistance. (Downward measurement is taken to be negative.)



		Phy	CS(Phy)
* A.	(1) and (3) only	(63%)	(51%)
B.	(1) and (4) only	(17%)	(20%)
C.	(2) and (3) only	(14%)	(20%)
D.	(2) and (4) only	(6%)	(9%)

8

10. A block of mass m resting on a 30° incline is given a slight push and slides down the incline with a uniform speed. Which of the following statements about the block's motion on the incline is/are correct ?

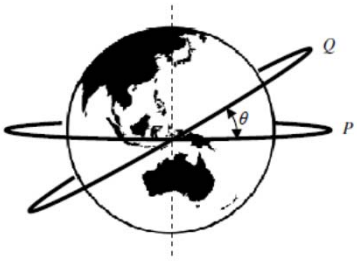


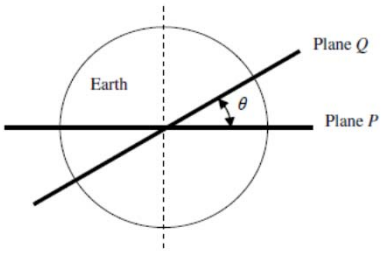
(1) There is no net force acting on the block.
(2) The frictional force acting on the block is 0.5 mg.
(3) If the block is given a greater initial speed, it will slide down the incline with acceleration.

		Phy	CS(Phy)
A.	(1) only	(18%)	(24%)
B.	(3) only	(13%)	(22%)
* C.	(1) and (2) only	(55%)	(38%)
D.	(2) and (3) only	(14%)	(16%)

9

14. Two satellites move in circular orbits of the same radius R around the Earth (mass M). The orbits are in two different planes P and Q as shown. Plane P coincides with the Earth's equator while plane Q is inclined to the equator at θ. Which statement is **INCORRECT** ?





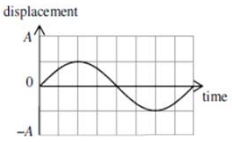
		Phy	CS(Phy)
A.	The speed of satellite P is $\sqrt{\frac{GM}{R}}$.	(8%)	---
B.	The centripetal force acting on satellite Q is pointing along the plane Q.	(16%)	---
C.	The acceleration of both satellites is the same in magnitude.	(18%)	---
* D.	The period of satellite Q is longer than that of satellite P.	(58%)	---

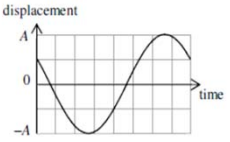
10

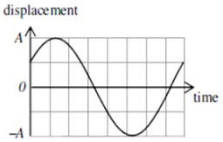
18. A stationary wave is formed on a string fixed at both ends X and Y. The following is a snapshot of the string at time $t = 0$. The amplitude of vibration at an antinode is A.

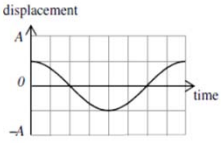
Which of the following shows the displacement-time graph of point P on the string for one period ? (Upward displacement is taken as positive.)

	Phy	CS(Phy)
A.	(8%)	(12%)
B.	(12%)	(16%)
C.	(18%)	(24%)
* D.	(62%)	(48%)

A.


B.


C.


* D.


11

22. The figure shows the waveforms of sound notes generated by a violin, a piano and a tuning fork. The scale is the same in time and intensity axes for all three waveforms.

(I)


(II)


(III)


Which of the following about the sound notes are correct ?

(1) They all have the same pitch.
(2) The qualities of sound of (II) and (III) are different.
(3) (I) is generated by the tuning fork.

		Phy	CS(Phy)
A.	(1) and (2) only	(14%)	(17%)
B.	(1) and (3) only	(7%)	(8%)
C.	(2) and (3) only	(25%)	(35%)
* D.	(1), (2) and (3)	(54%)	(40%)

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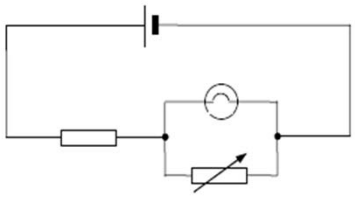
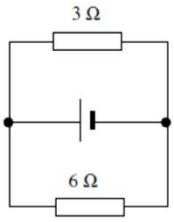
27. What will happen if the variable resistor is set to zero in the circuit below ?



		Phy	CS(Phy)
A.	The light bulb will burn out.	(6%)	(9%)
* B.	The light bulb will not light up.	(69%)	(56%)
C.	The brightness of the light bulb will increase.	(19%)	(25%)
D.	The brightness of the light bulb will remain unchanged.	(6%)	(10%)

13

28.

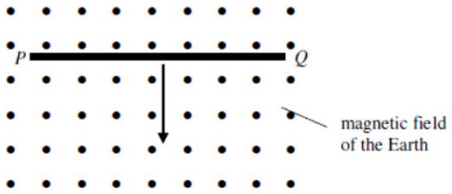


In the above circuit, the cell has e.m.f. 12 V and internal resistance 2 Ω. What is the current in the 6 Ω resistor ?

		Phy	CS(Phy)
A.	0.5 A	(7%)	(10%)
* B.	1.0 A	(42%)	(32%)
C.	1.5 A	(21%)	(22%)
D.	2.0 A	(30%)	(36%)

14

32. A copper rod PQ is placed horizontally as shown below. It is released and then falls vertically, cutting across the magnetic field of the Earth pointing out of the paper. Neglect air resistance. Which of the following statements is/are correct ?



(1) A voltage is induced across PQ.
(2) A steady induced current is generated in the rod.
(3) Due to the effect of the Earth's magnetic field, the copper rod falls with an acceleration less than the acceleration due to gravity.

		Phy	CS(Phy)
*A.	(1) only	(47%)	(30%)
B.	(3) only	(14%)	(18%)
C.	(1) and (2) only	(26%)	(32%)
D.	(2) and (3) only	(13%)	(20%)

15

Observations

- Most candidates were competent in handling calculations
- Some were weak in handling units/converting units
- Some were unable to identify which parameter(s) in an equation is/are constant/changing
- Essay questions or parts that require description were effective in discriminating the wide ability spectrum of candidates. Not many could present precise and concise answers.

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Points to note

- About 70% of Paper 1 (Physics) with questions from core part.
- Take g = 9.81 m/s^2 (accept also ans. using g = 10 m/s^2)
- In general, numerical ans. with 3 sig. fig.
- Test on graphs focuses on analysis instead of graph-plotting skills (already examined in SBA)
- Formulae list provided for each written paper
- Standards-referenced Reporting (SRR) – standard of each level maintained across years.

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Points to note

- SBA Streamlining

  2012 & 2013 Three experiments (20%)

  2014 & 2015 Two experiments (12%)
  + IS/EXPT* (8%)

  [IS or experiment* with detailed report]

18

THANK YOU

19

Paper 1B

Q1

(a) Candidates wrongly used 4200 J /kg/^{o}C for the s.h.c of steam.

(b) Many candidates forgot the energy released by water from 100^{o}C to temperature *T* in their calculation.

1

(a) Calculate the total amount of heat released when 20 g of steam at 110°C cools to 100°C and condenses to water at 100°C. (3 marks)

$E = mc\theta$

$E = 0.2(2000)(110-100) + 0.2 \times 4200$

$= 4000 + 840$

$= 4840\ J\ kg^{-1}\ ^{o}C^{-1}$

Level 2

2

(b) 20 g of steam at 110°C is bubbled through 200 g of milk at 15°C to make frothy milk. Using the result in (a), estimate the temperature of the frothy milk. (2 marks)

$4840 = \frac{a2}{20}(2000)(110 - x) + \frac{2}{200}(3900)(x - 15)$

$4840 = (44000 - 400x) + 7800x - 117000$

$4840 = -73000 + 7400x$

$x = 10.5$

∴ The frothy milk is 10.5°C.

Level 2

3

Q2

(a) Candidates had difficulties in calculating a spherical volume when applying Boyle's law.

(b) Few candidates stated the constant average speed (kinetic energy) of gas molecules and pointed out the gas pressure caused by collisions of gas molecules on a surface.

4

(b) Use kinetic theory to explain the change in gas pressure in the bubble as its volume increases.
(2 marks)

As the gas pressure decrease, the particle collide with the inner surface of the gas bubble less frequently, the force of the collision increase, therefore, the water bubble will expand, therefore, the volume will increase.

Level 3

5

$P_b V_b = P_s V_s$

$P_b = 1.01 \times 10^5 \times \left(\frac{V_s}{V_b}\right)$

$P_b = 1.01 \times 10^5 \times \left(\frac{1}{0.8}\right)^3$

$= 197\,265$

$= 197\,000$ Pa P_b (the req. pressure)

(b) Use kinetic theory to explain the change in gas pressure in the bubble as its volume increases.
(2 marks)

By kinetic theory, if the volume increases while the temperature ~~and~~ number of gas molecules remain unchanged, the number collisions between gas molecules and the wall will be less. Thus the pressure will decrease.

Level 5

6

Q3

(b) Some candidates misunderstood that the centripetal force remained constant while the friction became smaller

(c) Very few pointed out that the reduced friction was not enough to provide the centripetal force required.

7

(ii) Suppose the car takes lane 2 instead of lane 1 and the maximum value of the force providing the centripetal force is still 8000 N. Would the car's highest speed in lane 2 be smaller than, larger than or the same as that found in (a)(i) ? Explain. (2 marks)

As force $\propto \frac{v^2}{r}$, the radius decrease when the car travels at lane 2, In order to keep the force at 8000 N, the speed must increase. Therefore, the highest speed in lane 2 is larger than that found in (a)i).

(b) Explain why the chance of skidding would increase if there are oil patches on the road surface in Figure 3.1. (2 marks)

When there are oil patch, the friction between the car and the road will decrease, the maximum value of force decrease, if the car travell the same speed in (a)(i), the friction cannot provide enough force, making the car skis

Level 3

8

(ii) Suppose the car takes lane 2 instead of lane 1 and the maximum value of the force providing the centripetal force is still 8000 N. Would the car's highest speed in lane 2 be smaller than, larger than or the same as that found in (a)(i) ? Explain. (2 marks)

By $F_c = m\frac{v^2}{r}$, when r decrease and Fc and mass remain unchanged, the highest speed will be smaller.

(b) Explain why the chance of skidding would increase if there are oil patches on the road surface in Figure 3.1. (2 marks)

When there are oil patches, the friction which provides the centripetal force will decrease, the chance of skidding would increase.

Level 5

9

Q4

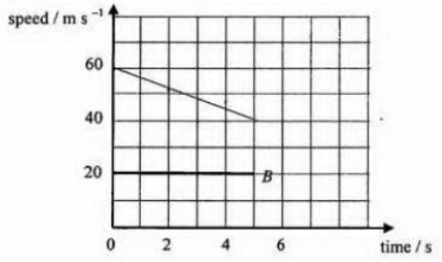
(a)(ii) Some candidates failed to sketch the variation of the speed of Train *A* correctly.

(b)(i) Many did not apply the principle of conservation of momentum correctly in the situation concerned.

(b)(ii) Only the more able ones identified the correct velocities to be used in finding the momentum change of Train *A*.

10

(ii) The graph below shows how the speed of B varies with time within this 5 s. Sketch on the same graph the variation of the speed of A within the same period. (1 mark)



(iii) Based on the above information, determine the separation x of the two trains at $t = 0$. (3 marks)

$v^2 = u^2 + 2as$, For Train A.

$40^2 = 60^2 + 2(-4)s$

$1600 = 3600 - 8s$

$8s = 2000$

$s = 250$

∴ Two trains are separate 250 m.

Level 2

11

(b) A and B locked together after collision.

(i) Find the speed of them just after collision. (2 marks)

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

$v^2 = 20^2 + 0$

$v = 40\ ms^{-1}$

(ii) If the collision time between the trains is 0.2 s and the mass of each train is 5000 kg, find the magnitude and direction of the average impact force acted on A during collision. (3 marks)

$5000 \times 40 \times 0.2$

$= 40000\ N$

Level 2

12

(b) *A* and *B* locked together after collision.

(i) Find the speed of them just after collision. (2 marks)

$m(40) + m(20) = 2m(v)$

$60m = 2m(v)$

$v = 30$

∴ The speed of the trains are 30 m/s after collision.

(ii) If the collision time between the trains is 0.2 s and the mass of each train is 5000 kg, find the magnitude and direction of the average impact force acted on *A* during collision. (3 marks)

$$\frac{(5000)(40) - (5000)(30)}{0.2}$$

$= 25000$ N (to the right).

Level 3

13

Q5

(a)(i)(ii) Weaker candidates had difficulties in the resolution of forces and in giving the correct unit for energy.

(b)(ii) Most candidates considered the motion of the arrow and worked out only coconut/arrow's height above the position where the arrow left the hunter's hand.

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5. (a) A bow and arrow is a kind of projectile weapon. The string of a bow is drawn taut by a hunter with a force of 60 N and an arrow of mass 0.2 kg is held stationary as shown in Figure 5.1.

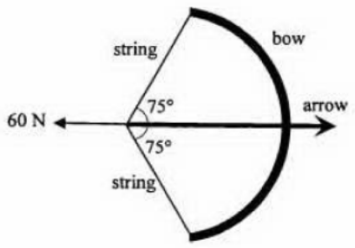

Figure 5.1

(i) Find the tension of the string. Neglect the weight of the arrow. (2 marks)

$60 = 2\sin 75^\circ \times$

$x = 31.1\ N$

Level 2

15

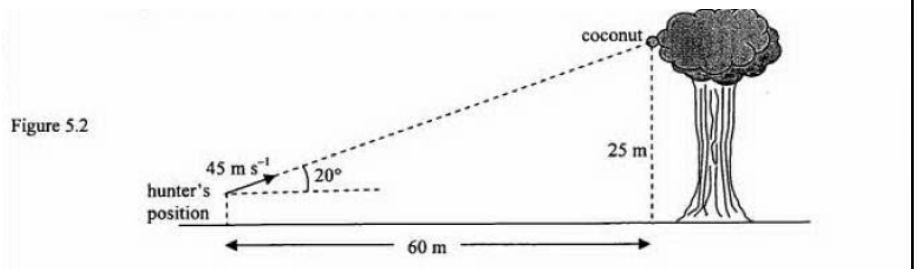

Figure 5.2

(i) Find the time taken for the arrow to hit the coconut. (2 marks)

$v = u + at$

$0 = 45 - 9.8t$

$t = 4.59\ s$

Level 2

16

(ii) Find the height of the coconut from the ground at the moment the arrow hits it. (2 marks)

~~25 m~~ $\frac{1}{2}mv^2 = mgh$

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

$h = -4.905$

$25 - 4.905$

$= 20.095$ m

Level 2

17

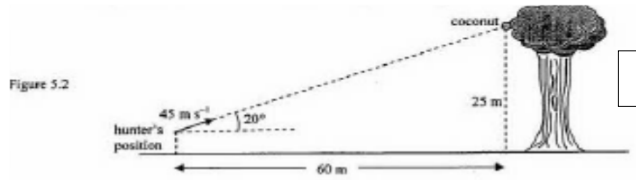

Figure 5.2

Level 3

(i) Find the time taken for the arrow to hit the coconut. (2 marks)

$60 \div (45\cos 20°)$

$= 1.25$ s

(ii) Find the height of the coconut from the ground at the moment the arrow hits it. (2 marks)

vertical component of the coconut : $s = ut + \frac{1}{2}at^2$

$= -\frac{1}{2}(9.81) \times (1.25)^2$

≈ -7.70 m

$25 - 7.70$

$= 17.3$ m //

∴ The coconut is 17.3 m from the ground.

18

Q6

(a) Many candidates wrongly drew straight lines for *L*1 and *L*2.

(b)(c) Satisfactory, though many failed to give the correct path difference at *Q*.

(d) Most candidates found the correct answer but some mixed up the meaning of Δ*y* (fringe separation) and *a* (slit separation).

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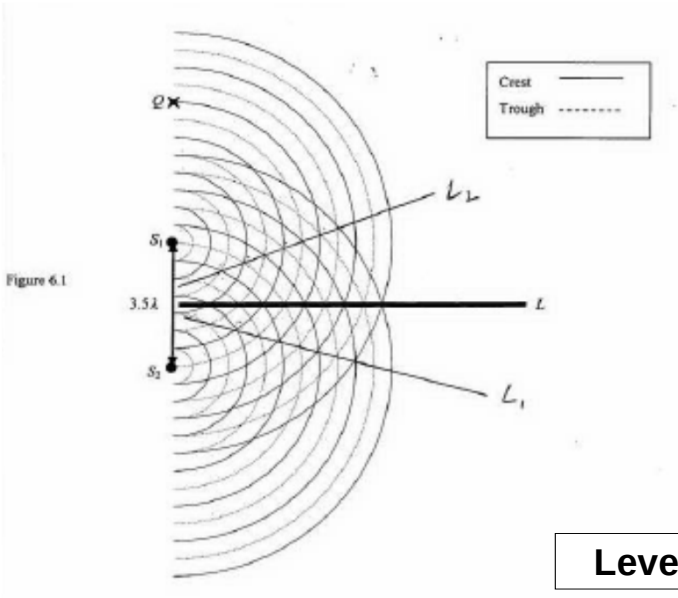


Figure 4.1

Level 3

20

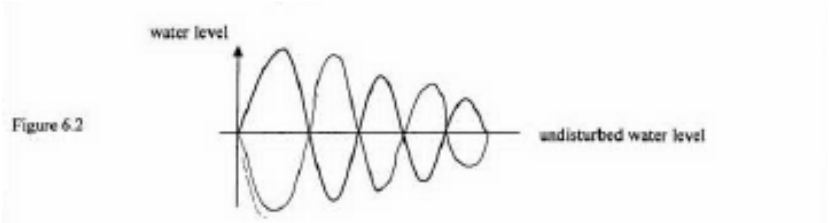


Figure 6.2

(c) Q is a point on the line joining S_1 and S_2 as shown in Figure 6.1. State the kind of interference that occurs at Q and give a reason for this occurrence. (2 marks)

Point Q will occur distructive interference. This is because at point P, the crest of wave S_1 will meet the trough of wave S_2. They will cancell out each other amplitude.

Level 3

21

Q7

(a)(i) Candidates drew the real image and light ray in dotted lines

(a)(ii) The light ray r reached the head of the image after through the lens.

22

Q7

- (b)(ii) Most candidates thought that longer distance ⇒ image was dimmer.
- Few can explain the difference in brightness in terms of

– light energy per unit area

– constant amount of light for diff. size of image

– light intensity followed inverse square law

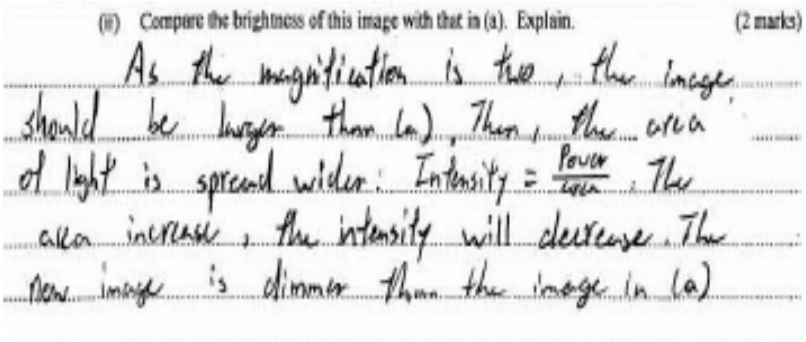
23

? (ii) Compare the brightness of this image with that in (a). Explain. (2 marks)

The brightness of this image should be dimmer than that in (a), since the distance between object and image in (b)(a) is 45cm while that of (a) is about 22.5cm. More light ray will be scattered by air molecules and dust in the air so the image is dimmer.

Level 3

24


(ii) Compare the brightness of this image with that in (a). Explain. (2 marks)

As the magnification is two, the image should be larger than (a). Then, the area of light is spread wider. Intensity = $\frac{\text{Power}}{\text{area}}$. The area increase, the intensity will decrease. The new image is dimmer than the image in (a)

Level 5

25

Q8

- (b) Some candidates used 550 W as the power consumed in the calculation.
- Some of them did not know greater power consumption when two resistors connected in parallel.
- (c) Some candidates only calculated the resistance of R_2 but not current through it.

26

Q9

- (a) Most candidates recited the given information without stated water can provide a conducting path or lower the resistance for an electric current.

  They just mentioned the bathroom was humid.
- (b) Very few correctly explained why the human body would not get an electric shock if only touching one of the shaver unit conducting wire.

27

Q9

- Most candidates reasoned that the conducting wire were isolated from high voltage.
- Few could explain person will not get electric shock because the current in the secondary circuit has no return path.
- Some of them thought that the current went to earth in the primary coil because of low resistance.

28

(a) Explain why the chance of electric shock is high in bathrooms. (2 marks)

It is because a bathroom is usually wet, and there are also electrical appliances working in the bathroom. Since there are some impurities in the water which help conduct electricity and the bathroom is usually at high humidity level, we have a higher chance of having electric shock in bathrooms.

Level 2

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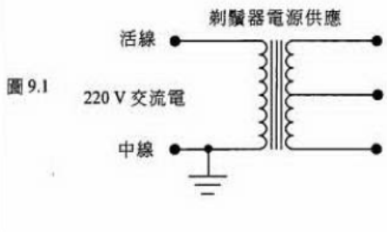
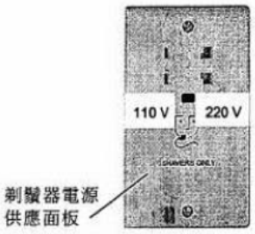


圖 9.1



(a) 解釋爲何在浴室受到電震的機會較高。 (2分)

由于浴室经常接触水，而水的导电性更好，所浴室里较容易触电。

Level 3

30

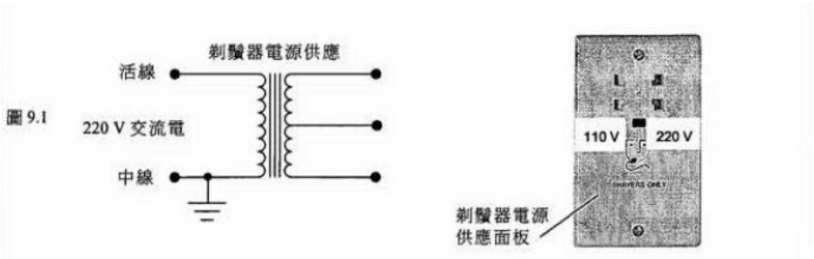


圖 9.1

(a) 解釋爲何在浴室受到電震的機會較高。 (2分)

浴室內空氣接觸到水
水是良好的導電體，令人體同時接觸水
和電插座或電器，電很可能流經人體，受到
電震

Level 5

31

(b) 解釋當人體接觸以下部件會有什麼事發生。

(i) 原線圈電路中市電電源的活線； (2分)

會觸電，令身體受傷。

(ii) 剃鬚器電路輸出口的其中一條導線。 (2分)

會感到有微弱的電流通過身體，但不會造成傷害。

Level 2

32

(b) 解釋當人體接觸以下部件會有什麼事發生。

(i) 原線圈電路中市電電源的活線： (2分)

当人接触了市电电源的活线，即220V，会出现休克甚至死亡的情况。

(ii) 剃鬚器電路輸出口的其中一條導線。 (2分)

只要是接触地线便会没事，其余都会出现b)提及的情况。

Level 3

33

(b) 解釋當人體接觸以下部件會有什麼事發生。

(i) 原線圈電路中市電電源的活線： (2分)

原線圈電具高電壓，如人接觸後會觸電把電源接地，造成電的弊害

(ii) 剃鬚器電路輸出口的其中一條導線。 (2分)

人體不會觸電

由於該電路輸出的是兩支交流電源完全分離，這麼只有由原線圈產生，若只接觸一條導線，電路就不會完整，電流不會產生，的感生電壓 所以人體不觸電

Level 5

34

Q10

- Many experimental set-ups were unclear.
- Some of them used apparatus other than that provided in the question, e.g.

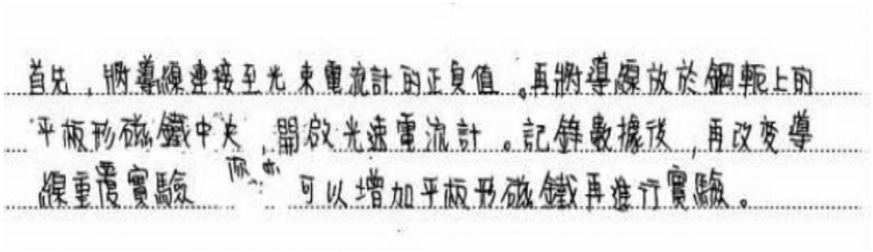
- stronger magnet
- longer magnet
- thicker conducting wire

35

Q10

- Some candidates did not know the conducting wire could be used as a conductor.
- Some mistook the light-beam galvanometer as a power supply or it could function as CRO.
- Some did not state the expected result or observation of the factors affecting the e.m.f.

36



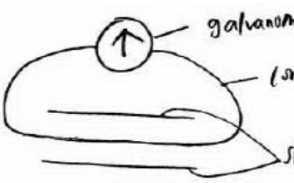
Level 2

37

Level 3

38

Level 5



There are 2 factors that can affect the ~~emf~~ induced in a conductor when it moves in a magnetic field. Which are the no. of coils in the magnetic field and the speed of moving the conducting wire. Firstly, connect the conducting wire to the light-beam galvanometer, then place a loop of the conducting wire between the 2 magnets on steel yoke. Move the coil ~~the~~ up and down and there will be induced current and the light-beam on the galvanometer will move. Then we can repeat the experiment by putting more loops of the conducting wire in between the magnets and the light-beam will move in a larger amplitude indicating that the induced current is larger. And this shows that the number of loops of the conducting wire ~~will~~ will affect the induced current. Then, ~~repeat~~ repeat the experiment by just placing one loop into ~~the~~ between the magnets but move the wire up and down at a higher speed. The light-beam on the galvanometer will also move in a larger amplitude showing that more induced current is produced. This can also show that the speed of moving the conducting wire in the magnetic field will affect the ~~emf~~ induced.

39

Q11

- (b) Weaker candidates made mistakes in converting units like u, MeV and J.
- (c) Many were weak in calculation with moles. Candidates mixed up curie (Ci) and disintegrations per second (or Bq) when expressing the activity.

40

(c) 1 curie (Ci) is defined as the activity of 1 g of radium. The activity of a radium source used in laboratories is about 5 μCi. Estimate the number of radium atoms in this source and hence find its activity expressed in disintegrations per second. The half-life of radium−226 is 1600 years and take the mass of one mole of radium as 226 g. ($1\ \mu Ci = 1\times10^{-6}$ Ci) (3 marks)

no of mole of Ra = $\frac{5\times10^{-6}}{226}$ = 2.21×10^{-8}

number of atoms = $2.21\times10^{-8}\times6.02\times10^{23}$

= 1.33×10^{16}

$A = A_0 e^{\frac{\ln 2}{1600\times365\times24\times60\times60}t}$ (1)

$A = A_0$

∴ the activity in disintegrations in $0s^{-1}$

Level 3

41

(c) 1 curie (Ci) is defined as the activity of 1 g of radium. The activity of a radium source used in laboratories is about 5 μCi. Estimate the number of radium atoms in this source and hence find its activity expressed in disintegrations per second. The half-life of radium−226 is 1600 years and take the mass of one mole of radium as 226 g. ($1\ \mu Ci = 1\times10^{-6}$ Ci) (3 marks)

$A = A_0$ N

$A \propto N$

$\frac{N}{N_0} \propto \frac{A}{A_0}$

$A = kN$

$= \frac{\ln 2}{1600\times365\times24\times3600} \times N$

$= 7.3184\times10^{-5} = 7.32\times10^{-5}$ disintegrations per second

no. of Ra atoms

$= \frac{1}{226}\times6.02\times10^{23}\times\frac{1}{5\times10^{-6}}$

$= 5.3274\times10^{26}$

$= 5.33\times10^{26}$

Level 4

42

(c) 1 curie (Ci) is defined as the activity of 1 g of radium. The activity of a radium source used in laboratories is about 5 μCi. Estimate the number of radium atoms in this source and hence find its activity expressed in disintegrations per second. The half-life of radium−226 is 1600 years and take the mass of one mole of radium as 226 g. ($1\ \mu Ci = 1\times10^{-6}$ Ci) (3 marks)

no. of Radium atoms

$5\times10^{-6} \div 1 \div 226 \times 6.02\times10^{23}$

$= 1.33\times10^{16}$ atoms //

$360\times24\times1600\times365 = \frac{\ln 2}{k}$

$k = 1.37\times10^{-11}$

$A = kN$

$= 183000$ (Bq)

Level 5

43

Paper 2A

Paper 2

Section A : Astronomy and Space Science

1

Q.1 Multiple-choice questions

	A	B	C	D
1.1	21.9	36.1	6.6	**31.3**
1.2	**35.4**	12.1	23.5	25.9
1.3	**53.5**	16.7	18.2	8.6
1.4	16.2	19.9	**43.9**	16.2
1.5	15.2	**42.9**	8.9	30.4
1.6	16.7	17.1	**36.2**	25.7
1.7	21.6	16.3	12.6	**44.3**
1.8	17.2	**59.5**	8.8	9.3

2

Q.1 Multiple-choice questions

1.1 Weightlessness occurs inside a spacecraft orbiting around the Earth. Which statement is correct ?

A. Weightlessness only occurs for objects inside a spacecraft orbiting around the Earth. (21.9%)

B. The gravitational attraction of the Earth in the spacecraft's orbit is so weak that the gravitational force is practically zero. (36.1%)

C. The gravitational attraction of the Earth is cancelled out by that of the Moon. (6.6%)

D. Both the spacecraft and the objects inside it undergo free fall towards the Earth. (31.3%)

Free falling is not restricted to one dimension only!

3

Q.1 Multiple-choice questions

1.2 An interplanetary spacecraft is launched from the Earth. The initial speed is $\sqrt{\frac{3GM}{R}}$, where G is the universal gravitational constant, M is the mass of the Earth and R is the radius of the Earth. What is the speed of the spacecraft when it is very far away from the Earth ?

A. $\sqrt{\frac{GM}{R}}$ (35.4%)

B. $\sqrt{\frac{GM}{2R}}$ (12.1%)

C. $\sqrt{\frac{2GM}{R}}$ (23.5%)

D. zero (25.9%)

4

Q.1 Multiple-choice questions

1.2 Solution

By conservation of energy,
sum of PE and KE at surface of Earth
= sum of PE and KE at infinity.

$$\frac{1}{2}m\left(\sqrt{\frac{3GM}{R}}\right)^2+\left(-\frac{GMm}{R}\right)=\frac{1}{2}mv^2+0$$

Straight forward but % correct < 50.

5

Q.1 Multiple-choice questions

1.3 The Sun is about 8 kpc from the centre of the Milky Way galaxy and its rotation speed about the centre is 220 km s^{-1}. How long does it take to complete one rotation about the centre of the Milky Way ?

A. 2.24×10^8 years (53.5%)
B. 3.55×10^8 years (16.7%)
C. 2.24×10^{11} years (18.2%)
D. 3.55×10^{11} years (8.6%)

6

Q.1 Multiple-choice questions

1.3 Solution

$$t = \frac{2\pi r}{v} = \frac{2\pi(8000 \times 3.09 \times 10^{16})}{220000 \times 3600 \times 24 \times 365}$$

or

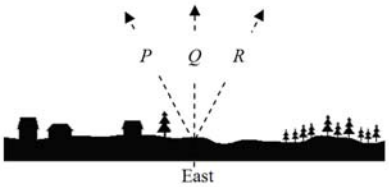
$$= \frac{2\pi(8000 \times 3.26)}{220000/(3 \times 10^{8})}$$

Quite simple! Slightly larger than 50%.

7

Q.1 Multiple-choice questions

1.4 The figure shows a view of the horizon when you are facing east in Hong Kong. Which arrow, *P*, *Q* or *R*, represents the direction in which the stars rise from the horizon ?



A. Arrow *P* (16.2%)

B. Arrow *Q* (19.9%)

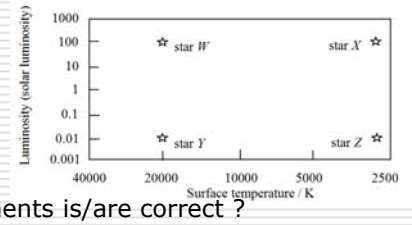
C. Arrow *R* (43.9%)

D. The direction varies according to the seasons. (16.2%)

A typical question but still less than 50%.

8

Q.1 Multiple-choice questions



1.7 Which of the following statements is/are correct ?

(1) For star *X*, the intensity of red light is higher than any other colour light.

(2) For star *W*, the intensity of blue light is higher than any other colour light.

(3) Intensity ratio of red light to other colours of light is larger in star *Z* than that in star *Y*.

A.(1) and (2) only (21.6%)
B.(1) and (3) only (16.3%)
C.(2) and (3) only (12.6%)
D.(1), (2) and (3) (44.3%)

9

Q.1 Multiple-choice questions

1.7 Solution

The answer can be deduced from Hertzsprung-Russell Diagram and black body radiation curve.

% correct < 50%

10

Q.1 Structured question

(a)(i) Show that $R = \left(\frac{T_S}{T}\right)^2 \left(\frac{L}{L_S}\right)^{\frac{1}{2}} R_S$ (2 marks)

- $L_S = \sigma T_S^4 (4\pi R_s^2)$
  $L = \sigma T^4 (4\pi R^2)$ ✓ 1M
- $\frac{L_S}{L} = \frac{T_S^4 R_S^2}{T^4 R^2}$ ✓ 1M

Many could not state Stefan's Law $L = \sigma(4\pi R^2)T^4$ correctly.
Most of them proved the relation by using $\frac{L_S}{L} = \frac{T_S^4 R_S^2}{T^4 R^2}$

1 mark only without stating Stefan's Law.

11

Q.1 Structured question

(a)(ii) Betelgeuse is a star with surface temperature 3650 K and luminosity 126000 times that of the Sun. Find the radius of Betelgeuse in terms of R_S. Take the surface temperature of the Sun to be 5780 K. (2 marks)

Sun	$T_S = 5780$ K	L_S	R_S
Betelgeuse	$T = 3650$ K	$L = 126000\ L_S$	R

$R = \left(\frac{5780}{3650}\right)^2 \left(\frac{126000 L_S}{L_S}\right)^{\frac{1}{2}} R_S$ ✓ 1M

$= 890\ R_S$ ✓ 1A

Well answered!

Only a few candidates could not find R because they misused the relation in (a)(i) or copied wrong data.

12

Q.1 Structured question

(b)(i) An estimate of the distance to Betelgeuse is 197 pc which corresponds to the luminosity given in (a)(ii). A measurement of this distance made in 2008 was 197 ± 45 pc. Without calculating the actual value, explain how the radius of Betelgeuse found in (a)(ii) would change if the upper limit of this distance measurement were used. (2 marks)

- Same brightness measured and brightness = $\frac{L}{4\pi d^2}$
- *d* is larger → *L* is larger ✓ 1M
- i.e. for Betelgeuse, $L \propto R^2$ → *R* increases.. ✓ 1M

13

Q.1 Structured question

(b)(i) An estimate of the distance to Betelgeuse is 197 pc which corresponds to the luminosity given in (a)(ii). A measurement of this distance made in 2008 was 197 ± 45 pc. Without calculating the actual value, explain how the radius of Betelgeuse found in (a)(ii) would change if the upper limit of this distance measurement were used. (2 marks)

Some of the candidates wrongly applied the equation $d = \frac{1}{p}$ to predicate the change of radius.

Some candidates mixed up luminosity and brightness.

14

Q.1 Structured question

(b)(i) An estimate of the distance to Betelgeuse is 197 pc which corresponds to the luminosity given in (a)(ii). A measurement of this distance made in 2008 was 197 ± 45 pc. Without calculating the actual value, explain how the radius of Betelgeuse found in (a)(ii) would change if the upper limit of this distance measurement were used. (2 marks)

Very few candidates could apply brightness = $\frac{L}{4\pi d^2}$ or $\propto \frac{L}{d^2}$ to explain explicitly that the luminosity should increase if distance increases for the same brightness.

15

Q.1 Structured question

(b)(ii) Suggest a reason why it is difficult to measure accurately the distance to Betelgeuse by the method of parallax. (1 mark)

- The parallax measurement is too small ($d = 1/p$, accurate to within ~ 100 pc)

  or d is too large (~ (1/200)" = 5 milliarcsec) ✓ 1M

16

Q.1 Structured question

(c) In 2011, some media reports suggested that when Betelgeuse undergoes a supernova explosion, it will appear as the "second sun" in the sky for a few weeks. Referring to the information given below, explain whether this is true or not by comparing the brightness of Betelgeuse in supernova explosion with that of the Sun. (3 marks)

- $L = 10^9 L_s$, brightness = $\frac{(0.01\times10^9 L_s)}{4\pi d^2}$ ✓ 1M
- d = 200 × 206265 AU = 41253000 AU ✓ 1M
- Brightness = $\frac{(0.01\times10^9)}{41253000^2}\frac{L_s}{4\pi(1\text{AU})^2}$
  = $\frac{(0.01\times10^9)}{41253000^2}$ brightness of the Sun
  = 5.88×10^{-9} brightness of the Sun ✓ 1A

17

Q.1 Structured question

(c) In 2011, some media reports suggested that when Betelgeuse undergoes a supernova explosion, it will appear as the "second sun" in the sky for a few weeks. Referring to the information given below, explain whether this is true or not by comparing the brightness of Betelgeuse in supernova explosion with that of the Sun. (3 marks)

Quite poor! Most of the candidates tried to compare the brightness of the Sun and supernova explosion by using either $d = 1/p$ or $L = \sigma(4\pi R^2)T^4$.

18

Paper 2

Section B : Atomic World

19

Q.2 Multiple-choice questions

	A	B	C	D
2.1	24.7	16.7	23.6	**33.8**
2.2	**46.6**	10.7	18.3	23.5
2.3	10.6	**50.7**	10.4	27.2
2.4	6.4	20.8	**63.9**	8.3
2.5	9.7	22.9	**52.7**	13.1
2.6	**74.7**	9.5	5.8	8.5
2.7	7.5	**60.0**	27.1	4.0
2.8	21.9	16.3	13.3	**47.0**

20

Q.2 Multiple-choice questions

2.1 From the classical point of view what are the limitations of Rutherford's model of the atom ?

(1) Atoms would continuously emit electromagnetic radiation.

(2) Atoms would be unstable and they would collapse eventually.

(3) The atomic emission spectrum would be continuous instead of discrete.

A.(1) and (2) only (24.7%)
B.(1) and (3) only (16.7%)
C.(2) and (3) only (23.6%)
D.(1), (2) and (3) (33.8%)

21

Q.2 Multiple-choice questions

2.2 Which of the following statements about spectra is/are correct ?

(1) A tungsten-filament lamp emits a continuous spectrum.

(2) A line absorption spectrum can be obtained when a tungsten-filament lamp is viewed through some hydrogen gas.

(3) The emission spectrum of hydrogen consists of dark lines on a bright background.

A.(1) and (2) only (46.6%)
B.(1) and (3) only (10.7%)
C.(2) and (3) only (18.3%)
D.(1), (2) and (3) (23.5%)

22

Q.2 Multiple-choice questions

2.8 If substance is reduced in size to become particles of about 10 nm large, which of the following properties of these particles would differ from those of the substance in bulk form ?

(1) optical
(2) mechanical
(3) electrical

A.(1) and (2) only	(21.9%)
B.(1) and (3) only	(16.3%)
C.(2) and (3) only	(13.3%)
D.(1), (2) and (3)	(47.0%)

23

Q.2 Structured question

(a) Explain the physical meaning of the negative sign of *E*. (1 mark)

Any 1:

- the electron is "bound" to the atom ✓
- the force between the nucleus and electron is attractive ✓
- work has to be done to remove the electron to infinity ✓

- 'negative charge' of electrons. ✗

24

Q.2 Structured question

(b) State TWO postulates of Bohr's model which are not "classical". (2 marks)

Any 2:

- The angular momenta of the electrons are quantized. ✓
- The electrons are in stable orbits without emitting radiation. ✓
- The electrons can occupy certain discrete orbits only. / Total energy of the atom is quantized. ✓
- The atom can only emit or absorb radiation in the form of a photon when an electron jumps from one energy level to another. ✓
- The emission spectrum is discrete. ✗

25

Q.2 Structured question

(c)(i) Calculate the energy of an ultraviolet light photon of wavelength 102.8 nm in eV. What is the quantum number? (3 marks)

- Energy = $hf = hc/\lambda = 1.93 \times 10^{-18}$ J
  $= 1.93 \times 10^{-18} / (1.60 \times 10^{-19}) = 12.09$ (eV) ✓ 1A
- $\Delta E = 12.09\,\text{eV} = -\left(\frac{1}{n^2} - \frac{1}{1^2}\right)13.6\text{eV}$ ✓ 1M
- $n = 3$ ✓ 1A
- 2nd excited state, therefore quantum number = 2 ✗

26

Q.2 Structured question

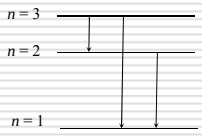
(c)(ii) Why does the 100.0 nm ultraviolet light pass through the hydrogen gas without absorption ? (1 mark)

- The energy of UV = 100.0 nm does not match the differences between ground state of hydrogen and other energy levels. ✓ 1A
- Because it is below the threshold frequency. ✗

27

Q.2 Structured question

(c)(iii) When the excited hydrogen atom returns to its ground state, how many transitions are possible? State which one of these transitions gives visible light and explain your answer.
Given : the energy of a visible light photon ranges from 1.7 eV to 3.2 eV. (3 marks)



- There are three possible transitions. ✓ 1A
- The hydrogen atom is in excited state n = 3.
  3 → 1 ΔE = 12.09 eV (= –1.51 –(–13.6))
  3 → 2 ΔE = 1.89 eV (= –1.51 –(–3.40))
  2 → 1 ΔE = 10.2 eV (= –3.40 –(–13.6)) ✓ 1M
- The transition from 3 → 2 corresponds to visible light as 1.89 eV is within the corresponding range. ✓ 1A
- There are two pathways. ✗

28

Paper 2C

Paper 2

Section C: Energy & Use of Energy

HKDSE 2012

1

Question 3

- Overall: >~50 %
- Best answered among all 4 questions.

2

Multiple Choice

Qn.	A	B	C	D
1	79.9	5.9	3.6	10.0
2	17.3	26.1	53.5	2.5
3	18.0	4.8	34.2	42.7
4	12.4	9.6	63.5	13.8
5	6.4	82.4	6.9	3.9
6	11.1	67.8	11.9	8.6
7	10.6	7.4	75.8	5.5
8	26.3	26.4	9.1	37.8

3

Qn. 3.3

Which sequence best describes the energy conversion in an electric vehicle's regenerative braking system during braking ?

A. kinetic energy → electrical energy (18%)
B. kinetic energy → chemical energy (5%)
C. kinetic energy → chemical energy → electrical energy (34%)
D. kinetic energy → electrical energy → chemical energy (43%)

4

Qn. 3.8

What would happen if the moderator of a nuclear fission reactor fails to function ?

A. The chain reaction might stop eventually. (26%)

B. Neutrons cannot be absorbed by the moderator. (27%)

C. Heat cannot be transferred to the steam generator. (9%)

D. The fuel rods might melt down. (38%)

5

Q.3 Structural question

(a) It is known that even on a clear day, the atmosphere absorbs an average of 26.8% of solar power. Find the maximum solar power per unit area reaching the Earth's surface. Given: solar constant = 1366 W m^{-2} (1 mark)

6

Q.3 Structural question

Maximum solar power per unit area reaching the Earth

= 1366 x (1 – 0.268)

= 1000 W m^{-2} or W

Comment: **Many candidates mixed up 0.268 and 1 – 0.268.**

7

Q.3 Structural question

(b) State the energy conversion of a solar cell and suggest a way to improve its absorption of energy. (2 marks)

8

Q.3 Structural question

Solar energy / radiation / radiant energy / light energy → electrical energy. 1A

- Adhere a transparent anti-reflection film to the solar cell panel.
- Methods involving tracking the sun to receive maximum sun light.
- Mirrors/lens to reflect/collect sun light to the solar cells. 1A

Comment:

- **Often involve heat or chemical energy in first mark.**
- **Some candidates think that painting the solar cell black can improve electrical energy generation.**

9

Q.3 Structural question

(c) *Solar Impulse* is a Swiss project to make a solar-powered aircraft that can fly long distances. Its first prototype HB-SIA has four engines driven by batteries which are charged by the solar cells installed on the aircraft. HB-SIA made a successful international flight in May 2011. The specifications of HB-SIA are as follows:

Power of each engine is 7.35 kW
The surface area of each solar cell panel = 0.0172 m^2
Conversion efficiency of solar cells = 12% during midday at normal incidence of solar radiation

(i)Assume that all the electrical power output of the solar cells is shared equally by the four engines. Estimate the number of solar cells required if each engine is driven to its full power. Assume that all the solar cells on HB-SIA receive the same solar power per unit area found in (a).(3 marks)

10

Q.3 Structural question

(c)(i)Solar power received by each solar cell
$= 1000\ W\ m^{-2} \times 0.0172\ m^2$
$= 17.2\ W$ (1 M)

Electrical power delivered by each solar cell
$= 17.2\ W \times 0.12$
$= 2.064\ W$ (1M)

Number of solar cells required

$$= \frac{7.35\ kW \times 4}{2.064\ W}$$

$= 14244$
$= 14244$ (1 A)

Comment

Not difficult. Most candidates can get the steps correct.

11

Q.3 Structural question

(ii) For the 2011 flight, a total of 11628 solar cells are installed on HB-SIA for a certain reason, which would not have been enough to drive the four engines to their full power. Suggest a practical reason for such a design. (1 mark)

12

Q.3 Structural question

ANY ONE

- To limit/minimize the weight of the aircraft.
- Limited area for installing the solar cells.
- It is the batteries to deliver maximum power to the engines, the solar cells are for charging the batteries.

Comment:

Not many can give a correct answer. Some candidates tried to explain why it is not *required* to have full power.

13

Q.3 Structural question

(d) Explain why solar power is said to be a *renewable energy source*. Besides solar power, suggest a renewable energy source that is *most feasible* to be used in Hong Kong. Justify your choice. (3 marks)

14

Q.3 Structural question

- Energy comes from natural resources / processes that are replenished constantly.
- Wind power
- as (northeast and southwest) monsoons prevail in Hong Kong (during winter and summer).

Comment:
Well answered. Some candidates said that there are suitable sites to build windmill without explanation of why these sites are suitable.

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Paper 2D

Paper 2

Section D: Medical Physics

HKDSE 2012

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Question 4

- Overall: <~40 %
- Worst answered among all 4 questions.

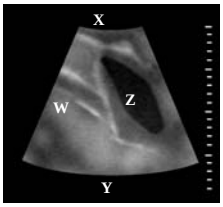
17

Multiple Choice

Qn.	A	B	C	D
1	45.8	23.2	19.2	9.2
2	35.2	6.6	46.5	9.6
3	26.4	54.6	7.1	9.9
4	8.2	17.0	33.1	40.6
5	21.8	12.8	56.3	7.8
6	9.6	23.1	14.7	52.0
7	21.4	17.1	16.1	46.3
8	17.5	9.3	38.3	34.9

18

Qn. 4.4



(1) *X* is closer to the scanner than *Y*.
(2) Area *Z* is low in brightness because it absorbs more ultrasound.
(3) Area *W* is high in brightness because it reflects more ultrasound.

A. (1) and (2) only (9%)
B. (1) and (3) only (17%)
C. (2) and (3) only (33%)
D. (1), (2) and (3) (41%)

19

Qn. 4.8

Which statements best explain why technetium-99m is suitable for the use of medical radionuclide imaging ?

(1) It can be combined with a wide range of chemicals and proteins to form radioactive tracers.
(2) Radiation exposure to patients can be kept low as the half-life of technetium-99m is short.
(3) It emits suitable γ radiations that can be attenuated by different tissues to give a radiographic image.

A. (1) and (2) only (18%)
B. (1) and (3) only (9 %)
C. (2) and (3) only (38 %)
D. (1), (2) and (3) (35 %)

20

21

Q.4 Structural question

4.(a) (i) Let v be the speed of ultrasound in soft tissue
v_b be the speed of ultrasound in bone
t be the time of travel of ultrasound in soft tissue
t_b be the time of travel of ultrasound in bone

$$\frac{v_b t_b / 2}{vt / 2} = \frac{5.8}{2.0} \qquad \text{1M}$$

$$\left(\frac{v_b}{v}\right)\left(\frac{3}{2}\right) = 2.9$$

$$\frac{v_b}{v} = 1.93 \qquad \text{1A}$$

Comment:
Many candidates could not use the graph to get the time within each layer. Some candidates mixed up the time of AC with the time of individual layers.

22

Q.4 Structural question

The values of acoustic impedance of various body tissues to the ultrasound used are tabulated below.

tissues	acoustic impedance / kg m^{-2} s^{-1}
soft tissue (average)	1.63×10^6
bone	7.78×10^6

(ii) If the speed of ultrasound in soft tissue is 1580 m s^{-1}, estimate the density of bone. (3 marks)

23

Q.4 Structural question

(ii) From (i), $v_b = 1.93 \times 1580$ m $s^{-1} = 3055$ m s^{-1} 1M

$\therefore$ for bone $Z = \rho c$ 1M

$7.78 \times 10^6 = \rho\,(3055)$

$\rho = 2547$ kg m^{-3} 1A

Comment:
Some candidates wrongly applied the acoustic impedance of the soft tissue (1.63 x 10^6 kg m^2 s^{-2}) which is useless for the question.
Quite a lot of candidates gave a wrong unit for density (e.g. kg m^{-1}, kg m^{-2}, kg m^3).

24

Q.4 Structural question

(b) (i) Describe the working principles of ultrasound B-scan imaging. (3 marks)

25

Q.4 Structural question

- Reflection of ultrasound at tissue boundary/when entering another tissue.
- The brightness/amplitude/strength in a B-scan image is proportional to the intensity of the reflected ultrasound signal/change in acoustic impedance.
- Distance/depth calculated from time for signal to return to ultrasound transducer./When traces are joined, a 2D/planar image of the scanned area is formed.

Comment:
The performance in (b)(i) is poor. Many candidates did not clearly state the location where reflection occurs. Some think that the brightness depend on attenuation. Not many candidates could explain how a 2-D image is produced.

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Q.4 Structural question

(ii) State **ONE** advantage and **ONE** limitation of using ultrasound scans in the context of medical imaging.

(2 marks)

27

Q.4 Structural question

Advantages (**ANY ONE**):

1. relatively safe (as no ionizing radiation involved)
2. readily accessible
3. can detect the movement of an organ in real time 1A

Limitations (**ANY ONE**):

1. limited tissue penetration, particularly through bones or air-filled structures
2. field-of-view (FOV) of ultrasound is smaller compared to other methods of imaging 1A

Comment:
Performance in (b)(ii) is good. Some candidates thought that radiation is equivalent to ionizing radiation and did not realize that ultrasound is also one kind of radiation.

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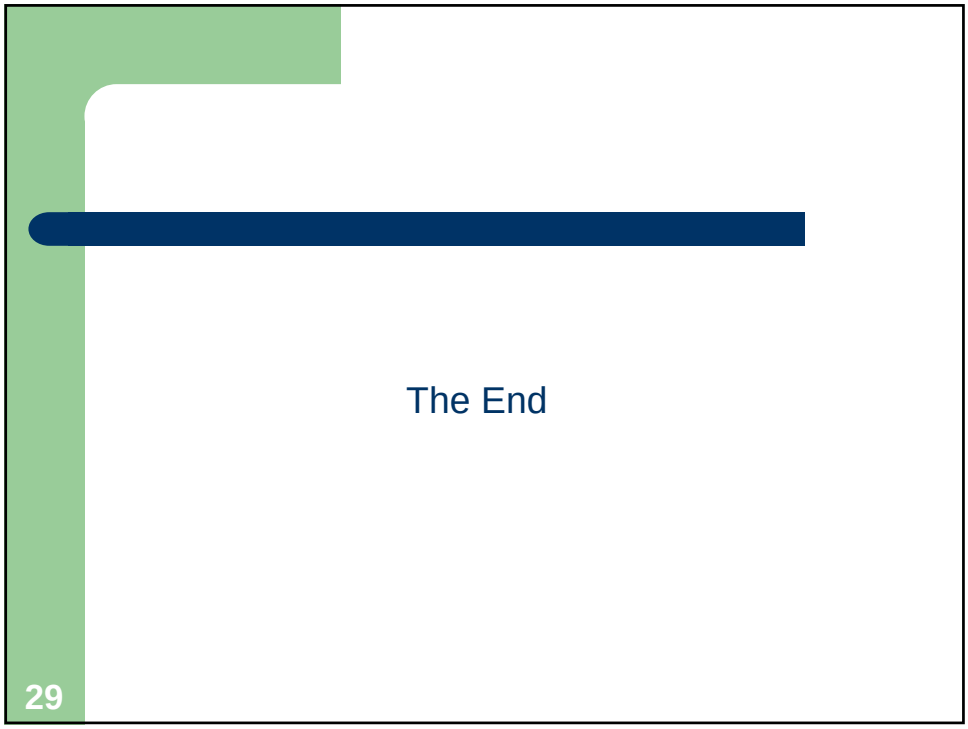
The End
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