2019 HKDSE Physics & Combined Science (Physics)

Report on Assessment

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Overview

Paper	Physics	CS(Phy)
1A (MC)	Mean: 19.2 out of 33 (i.e. 58%) (2018: 18.0 out of 32*)	Mean: 9.8 out of 22 (i.e. 47%) (2018: 9.8 out of 21*)
1B	~>50% (2018: <50%)	35%~40% (2018: ~>30%)
2	~>50% (2018: ~<50%)	N.A.
SBA	~>70% (~2017)	~<70% (~2017)
Candidature	ALL: 10692 SCH: 9 866	ALL: 272 SCH: 252

* one item deleted

Marking & Grading

On-Screen Marking (OSM) panels	
Physics	**CS(Phy)**
1B-1: Q.1, 3, 5, 6 (34M) 1B-2: Q.7, 8, 9 (25M) 1B-3: Q.2, 4, 10 (25M)	1B-1: Q.1, 2, 3, 4 (34M) 1B-2: Q.5, 6, 7 (22M)

2A: Astronomy (20%) 2B: Atomic World (66%) 2C: Energy (84%) 2D: Medical Physics (30%)	---

SBA marks stat. moderated (outlying cases ~10% schools reviewed by Supervisors)

Marking & Grading

- Expert Panel (Examiners, 4 ~ 5 persons) determine level boundaries/cut scores based on **Level descriptors / Group Ability Indicator (GAI) / Viewing candidate samples**.
- CS(Phy) graded by **Common items / Viewing candidate samples.**
- Endorsement by Senior Management/Public Exam Board

Note: GAI is generated from Physics candidates' actual percentage awards in 4 core subjects CEML.

Results

Physics

Cut score difference Δ = 49.3 %

Level	5**	5+	4+	3+	2+	1+
Percentage	2.7%	27.0%	49.8%	72.3%	90.0%	97.7%
No. of MC	31	24/25	19/20	15	11	8

CS(Phy)

Cut score difference Δ = 45.4 %

Level	5**	5+	4+	3+	2+	1+
Percentage	1.1%	6.3%	15.4%	37.1%	67.6%	89.0%
No. of MC	18	15	13/14	11	8	5

5

Paper 1A

Physics (33 MC)

>70%	50%-70%	<50%
4	21	8

Easy ⟷ Difficult

CS (Phy) (22 MC)

>70%	50%-70%	<50%
0	7	15

Easy ⟷ Difficult

6

PHYSICS MC

Topic (No. of Qu.)	Average % correct	No. of Qu. < 50% correct
Heat & Gases (3)	67%	0
Force & Motion (10)	54%	3
Wave Motion (9)	60%	1
Electricity & Magnetism (8)	56%	4
Radioactivity (3)	66%	0

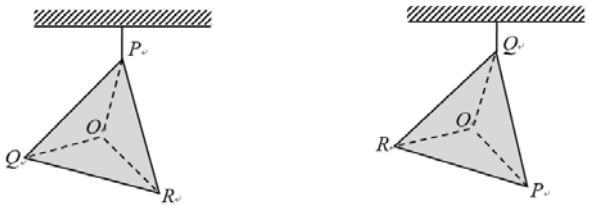
7

CS(PHY) MC

Topic (No. of Qu.)	Average % correct	No. of Qu. < 50% correct
Heat & Gases (2)	48%	1
Force & Motion (8)	38%	7
Wave Motion (8)	45%	4
Electricity & Magnetism (4)	45%	3

8

4.

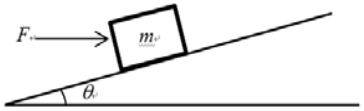


O is the centre of a metal plate PQR in the form of an equilateral triangle with **non-uniform** mass distribution. The plate is suspended from the ceiling at P and then at Q as shown. The centre of gravity of the metal plate is

A.	at O.		(14%)
B.	within the region POQ.	favourable distractor	(19%)
C.	within the region ROQ.		(10%)
*D.	within the region POR.		(57%)

Just over half of the candidates fully understood how to locate the centre of gravity of an object in practice.

5.

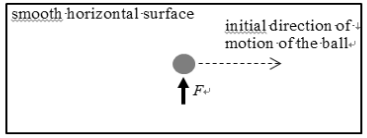


In the above figure, a horizontal force F is applied to a block of mass m so as to keep it at rest on a smooth incline making an angle θ with the horizontal. Find the magnitude of F.

			Phy	CS(Phy)
*A.	$\frac{mg\sin\theta}{\cos\theta}$		(50%)	(34%)
B.	$mg\sin\theta\cos\theta$	favourable distractor	(19%)	(11%)
C.	$\frac{mg\cos\theta}{\sin\theta}$		(14%)	(20%)
D.	$mg\sin\theta$		(17%)	(35%)

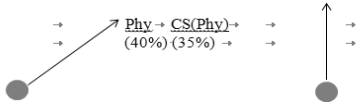
Half of the candidates managed to obtain the correct answer using resolution of forces.

10.



The above figure shows a ball moving with a constant speed along a straight line on a smooth horizontal surface. At a certain instant, the ball is acted on by a force F for a very short time as shown above. Which **subsequent** path below would the ball most closely follow?

*A.

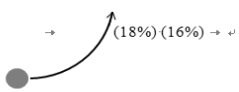


Phy CS(Phy)
(40%) (35%)

B.

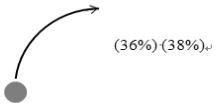
Phy CS(Phy)
(6%) (11%)

C.



(18%) (16%)

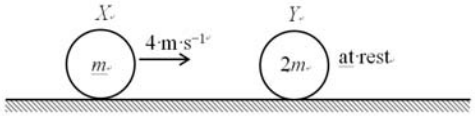
D. favourable distractor



(36%) (38%)

Over half of the candidates did not fully understand the inertial behaviour of objects and wrongly chose options C and D.

11.



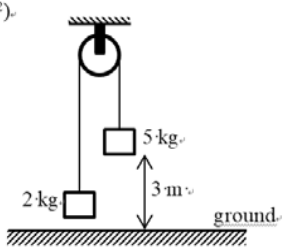
On a smooth horizontal surface, sphere X of mass m travels with speed 4 m s^{-1}. It collides head-on with another sphere Y of mass $2m$, which is at rest initially. Which of the following can be the speed of Y just after collision?

(1) 1 m s^{-1} (2) 2 m s^{-1} (3) 3 m s^{-1}

			Phy	CS(Phy)
A.	(1) only		(12%)	(17%)
*B.	(2) only		(27%)	(36%)
C.	(1) and (2) only	favourable distractors	(41%)	(33%)
D.	(2) and (3) only		(20%)	(14%)

Just over one-quarter of the candidates were able to obtain the correct answer.

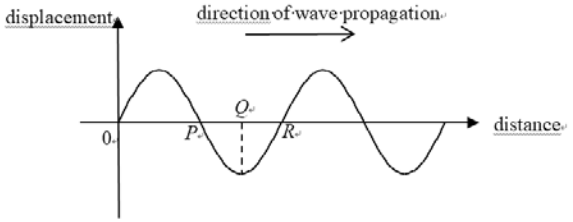
12. Two blocks of respective masses 2 kg and 5 kg are connected by a light inextensible string which passes over a smooth fixed light pulley as shown. The system is released from rest when the 5-kg block is 3 m above the ground. What is the speed of the 5-kg block just when reaching the ground? Neglect air resistance. ($g = 9.81\ m\ s^{-2}$)



		Phy	CS(Phy)
* A.	$5.0\ m\ s^{-1}$	(34%)	(15%)
B.	$6.0\ m\ s^{-1}$	(20%)	(20%)
C.	$6.5\ m\ s^{-1}$	(15%)	(20%)
D.	$7.7\ m\ s^{-1}$ favourable distractor	(31%)	(45%)

Over 30% of the candidates just considered the 5 kg block as a free falling object and arrived at the incorrect option D.

14. The figure shows the displacement-distance graph at a certain instant of a longitudinal wave which travels to the right. Displacement to the right is taken to be positive.



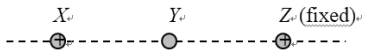
At the instant shown, which of the following statements is/are correct?

(1) P is a centre of compression.
(2) A particle with its equilibrium position at Q is at rest.
(3) A particle with its equilibrium position at R is moving downwards.

		Phy	CS(Phy)
A.	(1) only	(18%)	(14%)
B.	(3) only	(17%)	(24%)
* C.	(1) and (2) only	(35%)	(22%)
D.	(2) and (3) only favourable distractor	(30%)	(40%)

Nearly half of the candidates wrongly thought that the particle at R would move downwards for a longitudinal wave.

23.

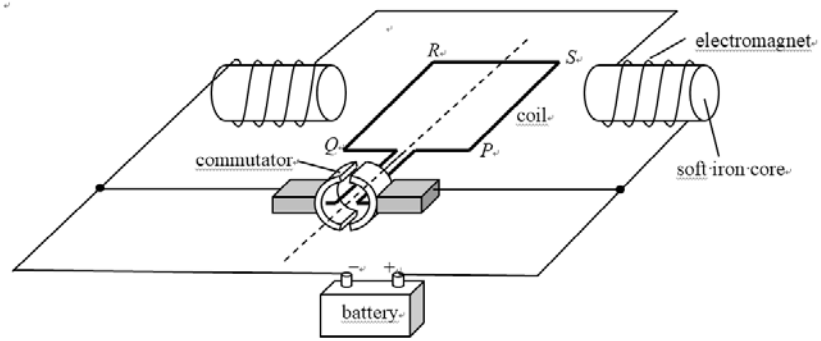


In the above figure, point charge Y is placed in the middle of two identical positive point charges X and Z, with Z being fixed. Both X and Y are in equilibrium and at rest initially. What would happen to X if Y is slightly pushed towards Z?

* A.	It moves towards the left.	(34%)
B.	It moves towards the right. favourable distractor	(25%)
C.	It remains at rest.	(23%)
D.	It cannot be determined as the sign of Y is not known.	(18%)

Not many candidates fully understood Coulomb's law and managed to obtain the correct answer.

27.



The figure shows the structure of a motor. The coil $PQRS$ and the two electromagnets are connected to a battery so that the coil rotates continuously. If a sinusoidal a.c. source of frequency 50 Hz is used instead of a battery, the coil will

		Phy	CS(Phy)
A.	remain at rest.	(13%)	(13%)
B.	oscillate at a frequency 50 Hz. favourable distractor	(23%)	(21%)
C.	rotate to a vertical position and then stop.	(20%)	(26%)
* D.	rotate continuously.	(44%)	(40%)

Less than half of the candidates realised that the direction of the torque always remains the same in this set-up when a sinusoidal a.c. source is used.

30. The power consumption of the heating element of an electric heater connected to an a.c. mains can be increased by

(1) increasing the electrical resistance of the heating element.
(2) increasing the frequency of the a.c. voltage.
(3) increasing the r.m.s. value of the a.c. voltage.

A.	(1) only	favourable distractor (26%)
*B.	(3) only	(45%)
C.	(1) and (2) only	(13%)
D.	(2) and (3) only	(16%)

About 40% of the candidates wrongly thought that the power consumption would increase when the heating element's resistance is larger and therefore chose options A and C.

分節符號 (下一頁)

Observations

- Candidates were competent in calculations but misconceptions were revealed in various questions which require qualitative responses or diagram drawing.
- Some fundamental physical concepts like refraction of waves and electromagnetic induction are not fully understood.
- Weak or careless in converting units or scientific notations.
- Weaker candidates ~25%.

Points to note

- ~70% of Paper 1 from core part.
- Method marks 'M' awarded to correct formula / substitution / deduction
- In general, numerical ans. with 3 sig. fig. Answer marks 'A' awarded to correct numerical answer with correct unit within tolerance range.
- Accept using $g = 9.81$ or $10\ m\ s^{-2}$.

Points to note

- Equating Electives (Total = 80 each) using Paper 1

Before equating: Mean 27 to 44 / SD 18 to 21
After equating: Mean 39 to 45 / SD 17 to 19

2A Astronomy:	↑↑
2B Atomic World:	↑
2C Energy:	~ unchanged
2D Medical Physics:	~ unchanged

Points to note

- Samples of performance of candidates (Levels 1 to 5) available in late October (HKEAA website).
- SBA Conference on 9 Nov 2019
- SBA Online Submission in Jan 2020
- 2020 DSE Phy Exam on 16 Apr 2020

Markers' Mtg:	Paper 1B	25/4
(tentative)	Paper 2	24/4

THANK YOU

HKASME PHYSICS SEMINAR 23-9-2019 & 24-10-2019

DSE PHYSICS 1B – Q1, 3, 5, 6

1. (a) An insulated container of negligible heat capacity contains 1.5 kg of tea at a temperature of 60 °C.

(i) What mass of ice at 0 °C should be added to the tea so that the final temperature of the mixture is lowered to 10 °C ? Assume that the specific heat capacity of tea is the same as that of water. (3 marks)

Given: specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}

specific heat capacity of water = 4200 J kg^{-1} °C^{-1}

Suggested solution

$(1.5)(4200)(60 - 10) = m(3.34 \times 10^5) + m(4200)(10 - 0)$ (2 M)

$m = 0.837766$ kg ≈ 0.838 kg

(Accept: $m = 0.83 \sim 0.84$ kg)

Let n be the mass of ice needed,

$1.5 \times 4200 \times (60° - 10°) = 3.34 \times 10^5 n + 4200 \times (10° - 0°) n$

$315000 = 376000 n$

$n = 0.838$

∴ 0.838 kg of ice is needed. 3

3

$E = mc\Delta T$

$= (1.5)(4200)(60-10)$

$= 315000$ J 1

$E_f = ml$

$315000 = m(3.34 \times 10^5)$

$m = 0.94$ kg (correct sig. fig.)

$E_{initial} = E_{final}$

$(1.5)(4200)(60) = m(3.34 \times 10^{-5}) + (1.5+m)(4200)(10)$

$378000 = (3.34 \times 10^{-5} + 4200)m + 4200$

$m \approx 89$ kg 1

4

(ii) If the heat capacity of the container is **not** negligible, explain whether more ice, less ice or the same amount of ice is needed to obtain the final temperature of 10 °C. (2 marks)

Suggested solution

More ice is needed

to cool the *container* as it will *release heat/thermal energy* as well.

5

The container releases heat when its temperature drops. Therefore, more ice is needed to absorb more heat.

2

2

~~If heat capacity~~ Temperature of the container should be same as the tea inside. If the heat capacity of it is not negligible, more heat is released from the tea and the container. More ice is required to absorb the heat released from the tea and container to have final temperature of 10°C.

6

More, as ice is required to cool down the container. ✓ 1

較多。
因為能量會以熱的形式散失給四周
環境 0 ✗

Same ✗ amount of ice. 0
Heat capacity (which mean $E=C\Delta T$) does not involve mass, ie mass of ice is not related to heat capacity.

7

(b) Some ice cream at −10 °C is put into a 'thermal bag', of which the inner layer is made of polyethylene foam coated with aluminium foil. The bag is also equipped with a zipper at the top.

The thermal bag is then brought outdoors on a hot sunny day.

8

(i) Referring to the heat transfer processes, explain **ONE** feature of this bag that helps keep the ice cream at a low temperature.

(1 mark)

Suggested solution

Foam is a poor conductor of heat as it minimize heat transfer from surrounding to ice cream inside the bag

The zipper prevents convection between the hot air outside and the cold air inside the bag

The shiny inner surface reduces emission of radiation from hot bag to cold ice cream inside the bag

9

The thermal bag avoid ~~direct~~ radiation from the Sun as its inner layer has coated with aluminium foil. ✗ 0

aluminium foil can reduced heat also absorbed by radiation since it is a poor emitter ✓ of radiation. 1

袋的內層鋪以鋁箔的發泡聚乙烯，能令雪糕(保持)於低溫，因為輻射 ✗ 0

10

袋的顶部配备3拉链，可减少热通过对流的方式进入，使雪糕保持低温。 1

袋的顶部拉链防止阳光以辐射的形式照射在雪糕上。 的热能量 0

发泡聚乙烯是一种不良的热导体，可以令外面的热和能量难以通过传递至袋内 1

The polyethylene foam can reduce heat gain by the bag through conduction as polyethylene foam is a poor heat conductor. 1

11

(ii) Suggest **ONE** modification to this bag that would enhance its ability to keep things stored inside at a low temperature.

(1 mark)

Suggested solution

Thickening the bag

or (Radiation) Make the outer surface (of the bag) shiny.

(any reasonable answers)

12

Use double layers of the bag which made by good heat insulator materials. 1

Cooler machine can be inserted to the bag 0

The bag can be vaccum, so that heat cannot transfer by conduction and convection 0

13

把袋的颜色改为白色，减少吸热。 1

在袋内放一些毛巾、棉花、保鲜袋所储物件，令包内的温度难以影响内的储存物件，同时亦减少因对流而出现的能量流失。 0

将拉链改用保鲜袋上的胶带密封。 1

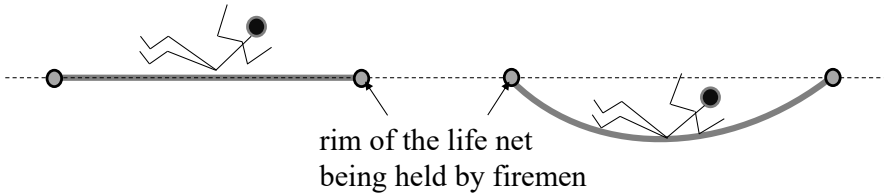
防止空气进漏。

14

3. Read the following passage about **life nets** and answer the questions that follow.

A life net is a rescue equipment formerly used by firefighters. It gives people on the upper floors of a burning building an opportunity to jump to safety, usually to ground level. It became obsolete due to advances in firefighting technology.

The practical height limit for successful use of life nets is about six storeys, although a few people once have survived jumps from an eight-storey building into a life net with various degree of injuries. The diagrams below explain its working principle.



When a person hits the net, it deforms and puts the person to a stop in a longer time as compared to hitting the solid ground.

(a) A person falls from a height of 12 m above a life net with negligible initial speed.

Neglect air resistance and the size of the person. (g = 9.81 m s^{-2})

(i) Estimate

(1) the vertical speed v and

(2) the time of fall t of the person just before hitting the life net.

(4 marks)

Suggested solution

3 (a) (i) (1) $\frac{1}{2}mv^2 = mgh$

$v^2 = 2(9.81)(12)$

v = 15.344054 m s^{-1} ≈ 15.3 m s^{-1}

(v =15.491933 m s^{-1} ≈ 15.5 m s^{-1} for g = 10 m s^{-2})

(2) $s = \frac{1}{2}gt^2$

$12 = \frac{1}{2}(9.81)t^2$

t = 1.564124 s ≈ 1.56 s

(t = 1.5491933 s ≈ 1.55 s for g = 10 m s^{-2})

take downwards as positive

$v^2 = u^2 + 2as$ ✓

$v^2 = 0 + 2(9.81)(12)$ 2

$v = 15.3\ ms^{-1}$ ✓ (cor to 3 sig fig) ✓

$v = u + at$ ✓

$15.3 = 0 + 9.81(t)$ 2

$t = 1.56\ s$ ✓ (cor to 3 sig fig) ✓

(1) $v^2 - u^2 = 2as$ ✓

$v^2 - (0)^2 = 2(9.81)(12)$

$v = 15.3\ ms^{-1}$ ✓ 2

(2) $s = ut + \frac{1}{2}at^2$ ✓ 1

$12 = (15.3)t + \frac{1}{2}(9.81)t^2$

$12 = 15.3t + 4.905t^2$

$t = 0.648\ s$ ✗ or $-3.78\ s$ (rej)

$v^2 = u^2 + 2as$ ✓

$v^2 = 0 + 2(9.81)(12)$ ✓

$v = 15.3\ ms^{-1}$ ✓ 2

$s = ut + \frac{1}{2}at^2$ ✓

$12 = 0 + \frac{1}{2}(9.81)t^2$

$t = 1.56\ s$ ✗ 1

(b) $v = 9.81\ ms^{-1}$ ✗ 0

✗

(2) $t = \frac{12}{9.81} = 1.22\ s$ 0

(ii) If this falling person of mass 70 kg is stopped in 0.3 s by the life net, estimate the average force acting on the person by the net within this time interval. (3 marks)

Suggested solution

$F - mg = ma$

$F = \frac{70 \times (15.3 - 0)}{0.3} + 70 \times 9.81$

$= 4266.9793\ \text{N} \approx 4270\ \text{N}$

($F = 4314.7845\ \text{N} \approx 4310\ \text{N}$ for $g = 10\ \text{m s}^{-2}$)

$F = m\left(\frac{v-u}{t}\right)$

$R - 70\times 9.81 = 70\left(\frac{15.3}{0.3}\right)$ 3

$F = 4256.7\ N$

$F = \frac{mv-mu}{t}$

$F = \frac{70(15.3-0)}{0.3}$ 1

$F \doteq 3580\ N$

23

$F = ma$

$F = m\left(\frac{v-u}{t}\right)$

$F = \frac{70(0-15.3)}{0.3}$ 1

$F = -3570\ N$

∴ 救生網施於他的向上 3570 N

$F = ma$ ✗

$F = 70(9.81)$

$F = 686.7\ N$ 0

24

(iii) What form of energy is stored by the life net during the deceleration of the falling person ? (1 mark)

Suggested solution

Elastic potential energy

25

Elastic potential energy 1

彈力勢能 1

Potential energy 0

动能+勢能 0

下墮者的動能所產生的勢能 1

Kinetic energy 0

張力 0

26

(b) (i) Give a reason why there exists a height limit of using life nets. (1 mark)

Suggested solution

(Greater than height limit, final velocity is too great, hence the force for deceleration is too large.)

The life net may be torn.

or The falling person may be injured

or The firemen are not able to hold the life net tight.

27

Since if the height is too high, the vertical speed of person hitting the net will be so high, increasing the average force acted on net and the net may break which may cause person die ✓ 1

当高度超过人反弹时，下坠者的冲力会远大于救生网的承受能力。 ✗ 0

Different height has different potential energy and the force that life nets can withstand is different. ✗ 0

28

*(ii) The falling person might hit the rim of the net, thus the person or the firemen holding the rim would be injured. Explain why it is not easy for a person jumping from a height to reach the life net's central part. (2 marks)

Suggested solution

There exists a *horizontal velocity* when a person jumps and

the *horizontal displacement* is very *difficult to estimate* as it depends on the time of fall, which is usually long.

29

It is because the person can hardly estimate the horizontal velocity he needs. He doesn't know the time of flight. He cannot predict the time of flight before he jumps. In the air, he can no longer adjust his horizontal speed. He may over-estimate or under estimate the horizontal velocity he needs. ✓ ✓ 2

Actually the falling person would have horizontal velocity when falling. Thus, the horizontal range of the person when falling is difficult to estimate ✓ It is difficult for firemen to put the net such that the falling person exactly reaches the central part ✓ 2

30

Although it has no vertical velocity act on but it has a small initial horizontal ✓ velocity. Therefor it will have horizontal ✓ displacement. It is hard to jump to central part. 2

因为当人下坠时会以不规则姿势落下，从而不易落到中部分。另外，当下坠为撞到边缘会时握着边缘的时候受到大量的冲力，从而导致受伤。 0

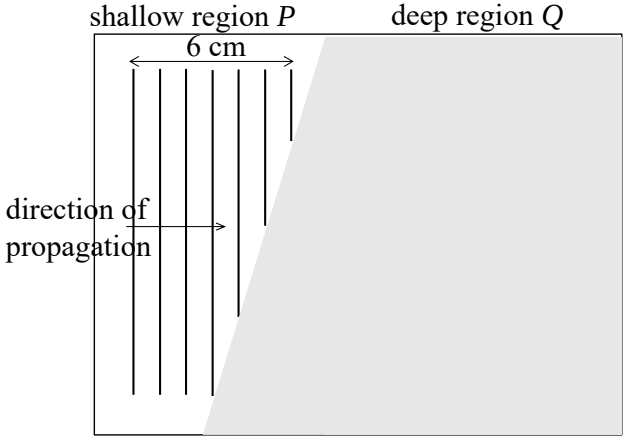
31

因下坠者向前跳下时，具有水平初速向前✓在下降时会呈现平抛运动，有向前的位移，所以预计下降的位置。 2 ✓

因為跳下去時有機會使出一個向前的力，令自身不是垂直✓下降，加上人有四肢，平衡所以很難落到中央部分。 1

32

5. A ripple tank has a shallow region *P* and a deep region *Q*. Straight water wave of frequency 10 Hz is travelling in the shallow region as shown in Figure 5.1 when viewed from above.



Top view

33

(a) The separation between seven crests in the shallow region is found to be 6 cm as shown.

(i) Find the wavelength of the wave in the shallow region.

(1 mark)

Suggested solution

wavelength $\lambda = \dfrac{0.06}{7-1}$

$= 0.01$ m (= 1 cm)

34

λ = b/f ✓
= 1 cm ÷ 0.01 m 1

波長 = 6m ÷ 7 ✗
波長 = [illegible] 0.857m 0

λ = 6 ÷ 7 ÷ 100
= 8.57 × 10⁻³ m ✗ 0

λ = 6 × (0.06) = 0.67λ ✗ 0

35

(ii) What is the wave speed in the shallow region ? (1 mark)

Suggested solution

speed $v = f\lambda = 10 \times 0.01$

$= 0.1 \text{ m s}^{-1}$ ($= 10 \text{ cm s}^{-1}$)

36

v = fλ
v = 10 × 0.01 = 0.1 ms⁻¹ ✓ 1

(i) Find the wavelength of the wave in the shallow region.

6 cm ✗ 0

(ii) What is the wave speed in the shallow region ?

v = fλ
v = 10 (6) ✓ 1
v = 60 ms⁻¹

37

(a) The water wave then propagates into the deep region where the wavelength of the wave is double that in the shallow region.

(i) State the frequency of the water wave in the deep region.

(1 mark)

Suggested solution

frequency = 10 Hz

38

10 Hz ✓ 1

20 = f (2x2) f = 5 Hz ✗ 0

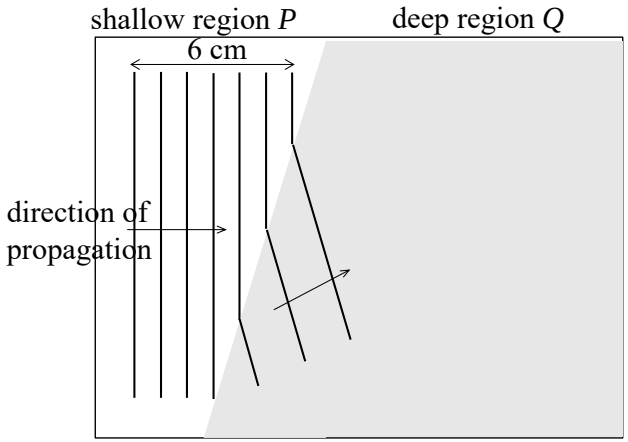
remain unchange. 10 Hz. ✓ 1

remain unchanged. ✗ 0

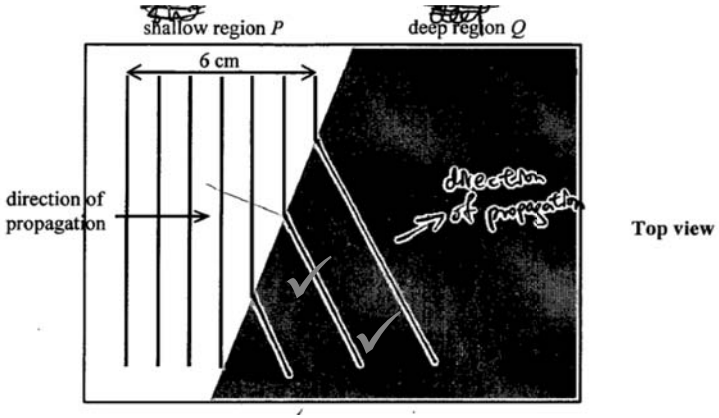
39

(ii) On Figure 5.1, sketch the wave pattern in the deep region.

(2 marks)

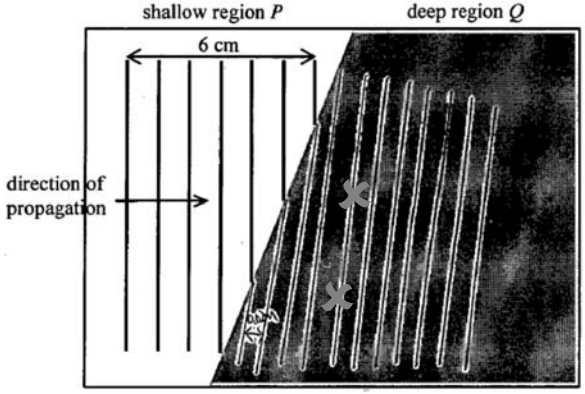


40



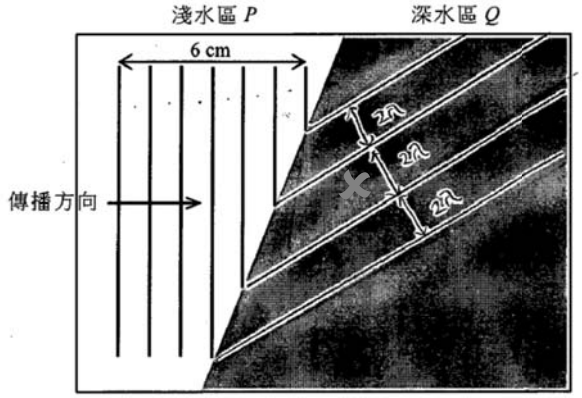
2

41



0

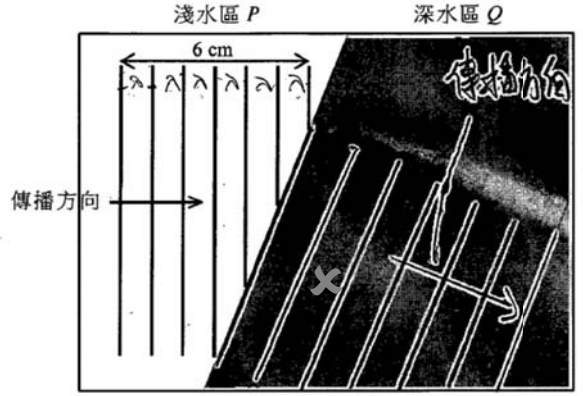
42



0

鳥瞰圖

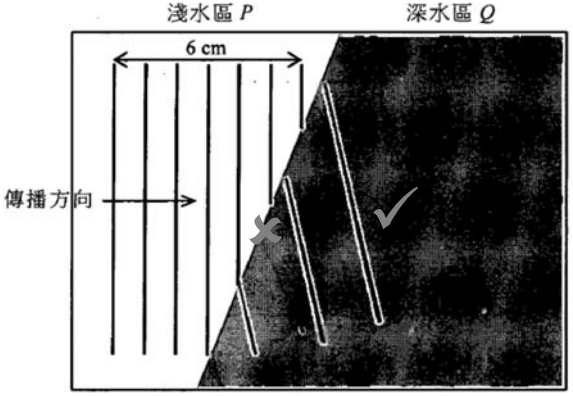
43



鳥瞰圖

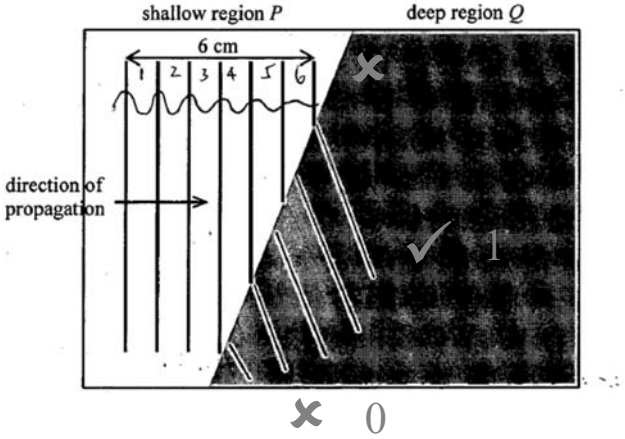
0

44



鳥瞰圖

45



Top view

1

0

46

(iii) Name the phenomenon occurred across the boundary and explain its cause. (2 marks)

Suggested solution

Refraction

It is due to the *change in wavelengths / wave speeds* in different media/depth

47

Refraction ✓ water wave travels from shallow region to deep region. water wave travels in different medium and have different speed ✓ in different medium. Refraction occurs. 2

Refraction ✓ when waves enter the deep region, the wavelength increases ✓ that they bend towards the normal. 2

Refraction ✓ because the refractive ✗ index is difference in shallow and deep region 1

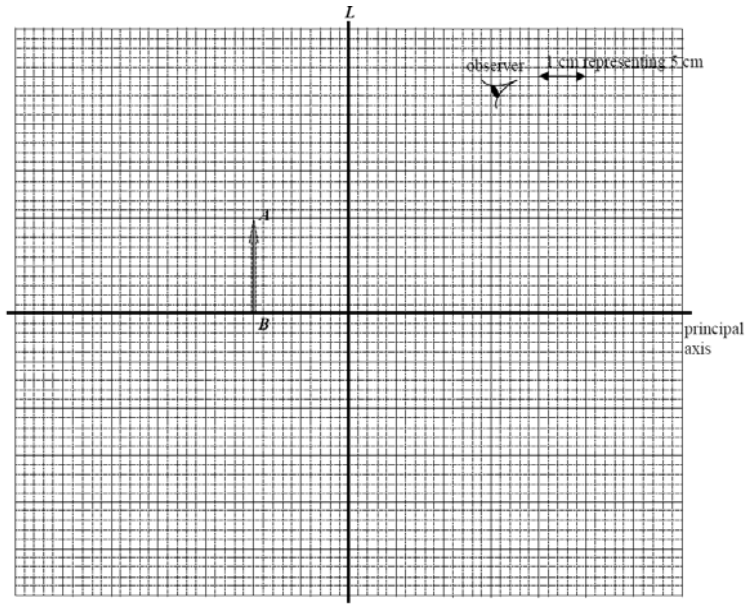
48

折射，因为水波从浅水区传播至深水区，波长增加，✓ ✓
速率不变，频率增加，所以发生折射。 1
✗

Diffraction ✗ occurs, It's because ~~the~~ Shallower region water went to deeper region. ✗
0

49

6. In Figure 6.1, *AB* represents the virtual image of an object formed by lens *L*. The magnification of the image is 0.4. The horizontal scale is 1 cm to 5 cm



50

(a) What kind of lens is used ? Explain. (2 marks)

Suggested solution

L is diverging/concave.

Only diverging/concave lens forms diminished, virtual image.

51

Concave ✓ lens. The mage formed is virtual ✓ and diminished. ✓ 2

凹透✓鏡，因为只有凹透鏡能产生虛✓像，縮小✓，正立的像 2

1

concave ✓, because the magnification ✗ of the image is ~~less~~ 0.4 (less than 1).

52

1

凹✓透鏡，凹鏡所成的像为虛✗像.

1

凹✓透鏡，因为像在鏡子的右面，与物为異侧✗

✗ 1

凸透鏡，因为所形成的虛✓像，其放大率为 0.4 ✓

53

(b) Indicate on Figure 6.1 the position and height of the object. (2 marks)

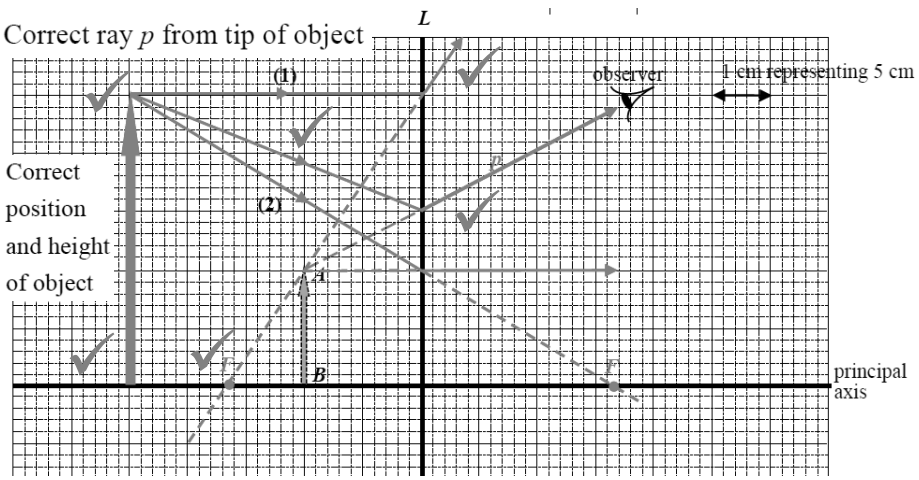
(c) By drawing a suitable light ray, locate and mark the position of the focus, *F*, of the lens. Find the focal length of the lens.

(3 marks)

Focal length = …….

(d) Draw a light ray emerging from the object to illustrate how the observer in the figure can see the tip *A* of the image. (2 marks)

54



Correct ray to locate *F* and focus *F* correctly marked.
16.5 cm (Accept 15.5 cm – 17.5 cm)

55

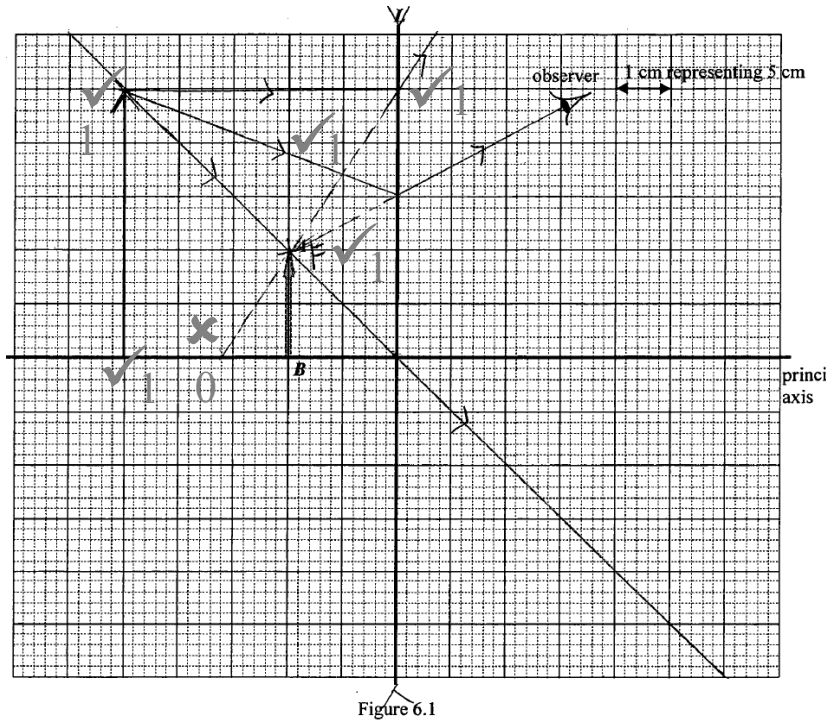


Figure 6.1

56

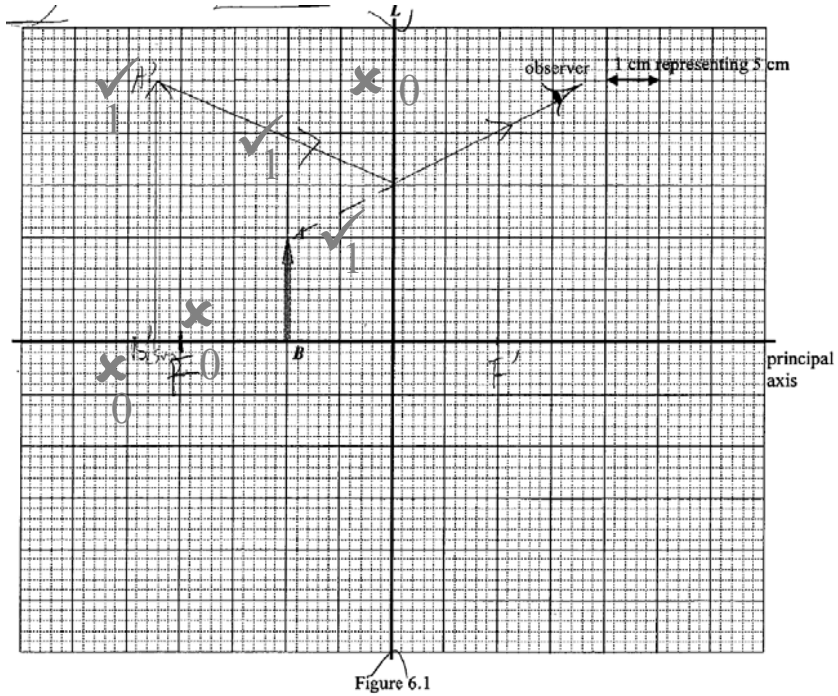
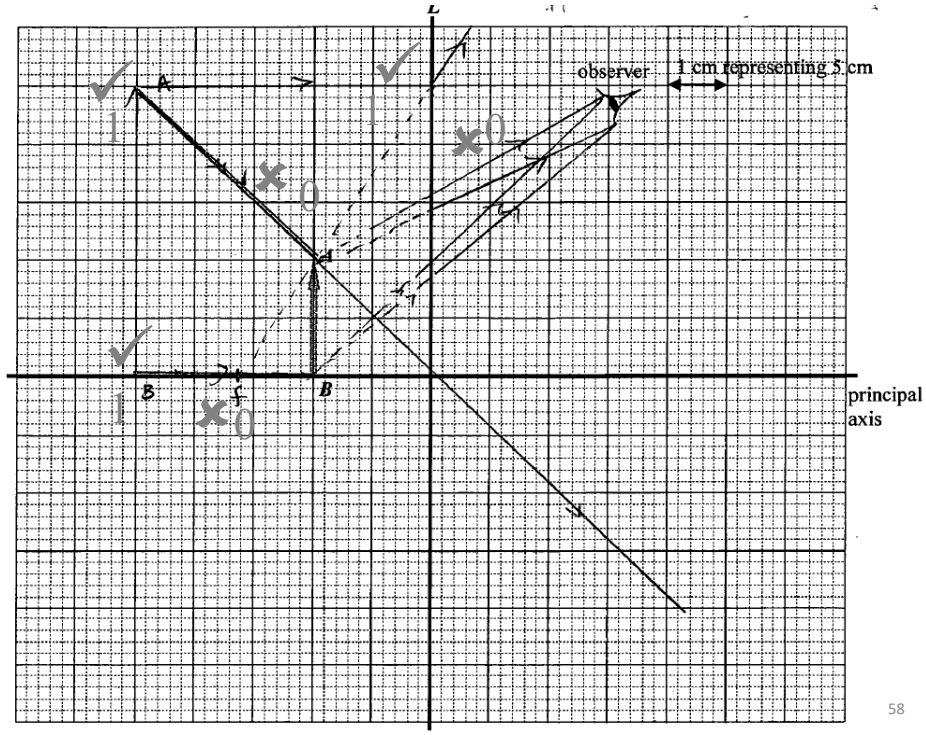
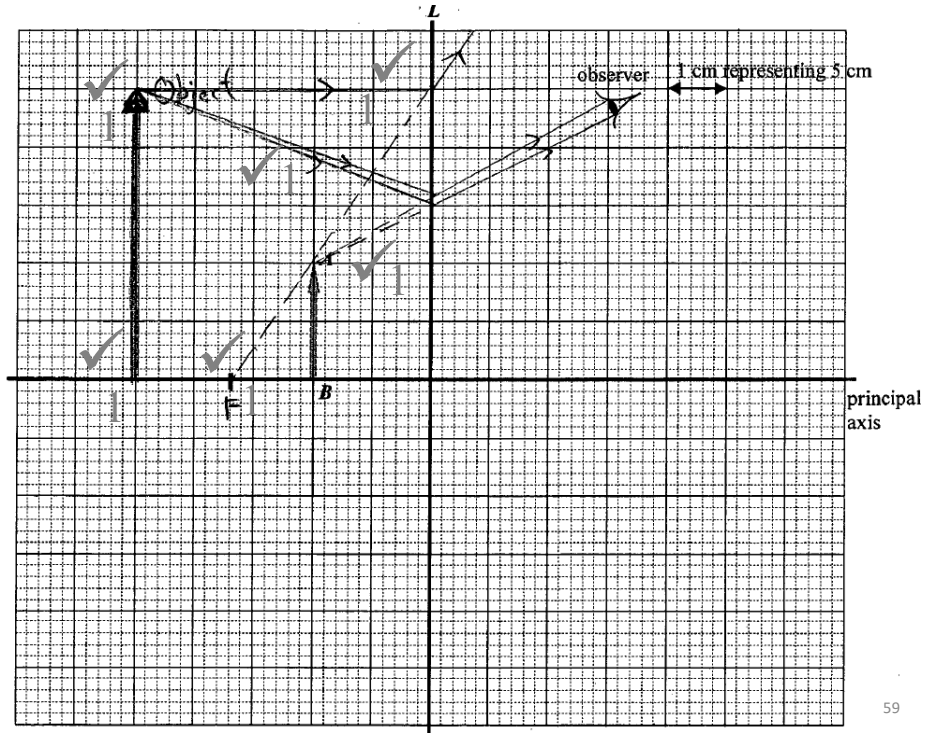


Figure 6.1

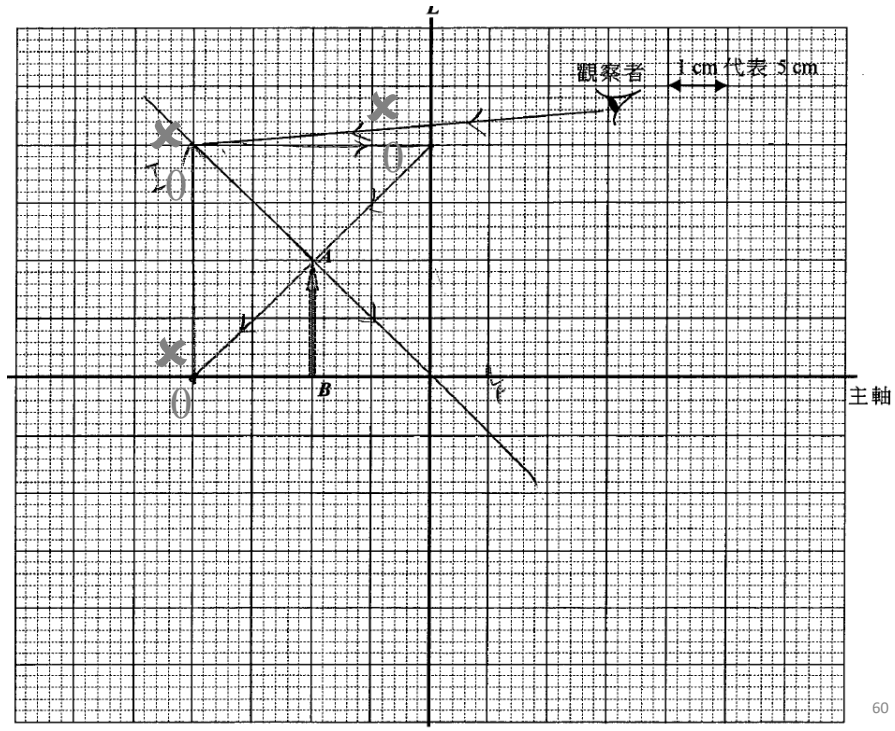
57



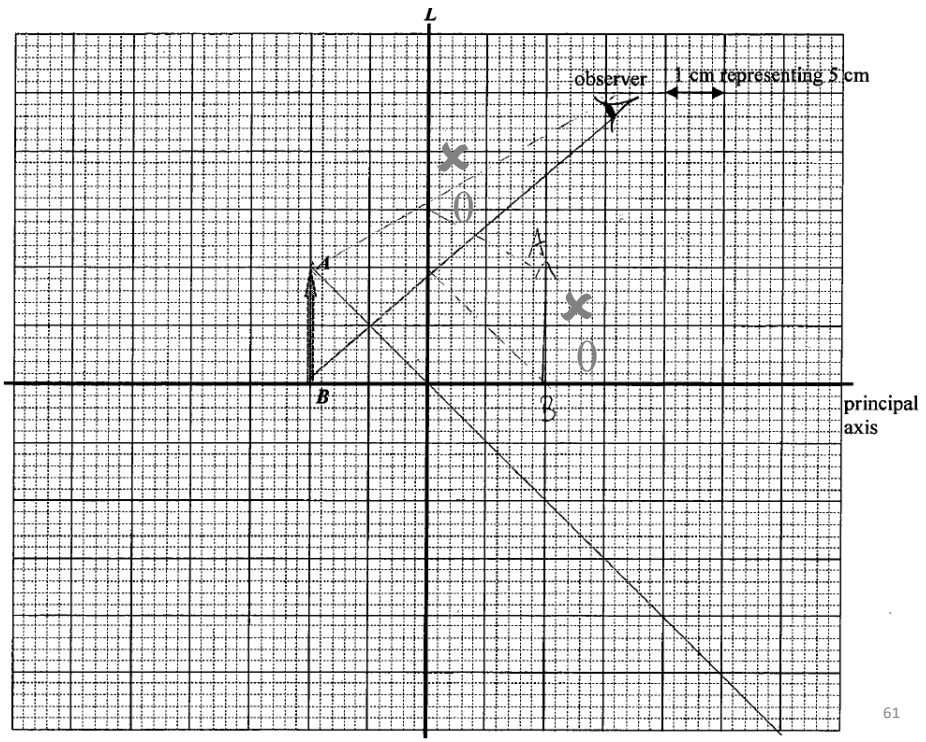
58


L
observer
1 cm representing 5 cm
Object
A
B
F
principal axis

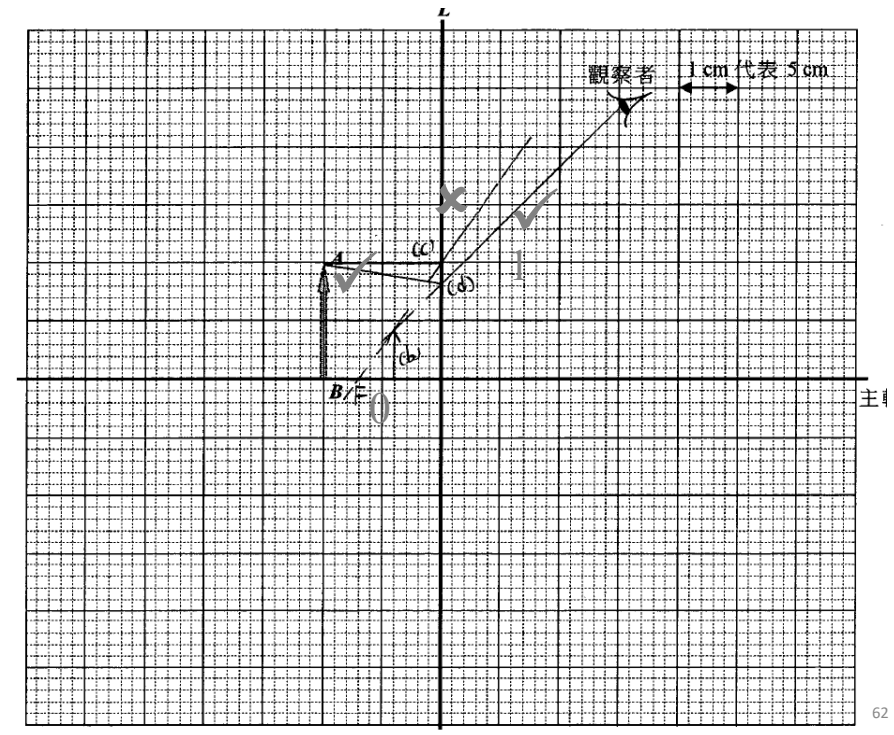
59


L
觀察者
1 cm 代表 5 cm
A
B
F
主軸

60


L
observer
1 cm representing 5 cm
A
B
principal axis

61


L
觀察者
1 cm 代表 5 cm
A
B/F
主軸

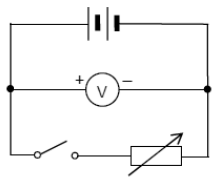
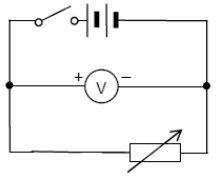
62

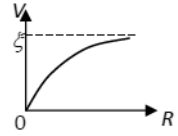
Thanks

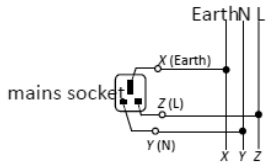
2019 HKDSE - Physics

1B-2

QUESTIONS 7, 8 & 9

Solution	Marks	Remarks
7. (a) 	1A 1A	Correct circuit with correct symbol Correct polarity
		Alternative circuit 
Close the switch and record corresponding V and R readings Adjust the resistance R to lower/other value(s) and repeat the experiment	1A 1A	
Precaution: - First set the variable resistor to its maximum/a large value - Open the switch after each measurement - Any reasonable answer	1A	NOT accept Change of apparatus e.g. Using thicker connecting wires etc. Any ONE
	5	

(b) Terminal voltage V delivered increases with increasing (loading) resistance R (or graphical representation) $V = \xi \frac{R}{R+r}$ OR $V = \xi - \frac{\xi}{R+r} r$	1A 1A 2	Accept  NOT accept V is directly proportional to R V varies linearly with R

Solution	Marks	Remarks
8. (a) 	1A 1	

(b) (i) - If one of the lighting sets/circuits fails, the other (in parallel) can still operate, i.e. both work independently.
- Both can work at the rated power.
- Any reasonable answer

Any ONE — 1A — 1

(ii)
$P = IV$
$(300 + 450) = I(220)$ — 1M
$I = 3.409091\ \text{A} \approx 3.41\ \text{A}$ — 1A
Thus 5 A fuse should be used. — 1A — 3

1M for calculating currents in both branches
1A for total current (3.41 A)
1A for correct deduction

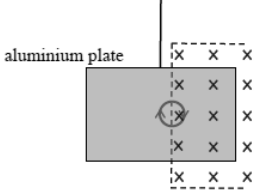
(c) Electrical energy used per day
= 0.500 kW × 8 h + 2 kW × 0.5 h + 3 kW × 2 h — 1M
= 11 kW h
Cost = \$0.9 / kW h × 11 kW h — 1M
= \$9.9 — 1A — 3

1M for calculating energy used
1M for \$0.9 × energy used
1A for correct answer

Solution	Marks	Remarks
9. (a) (i) By Lenz's law, an e.m.f. would be induced such that it opposes the change, i.e. decrease of magnetic flux (into the paper) by driving an induced current (clockwise) in the coil/circuit (complete).	1A 1A 2	1A for induced emf 1A for the change of magnetic flux
(ii) $N\Delta\Phi = NBA$ $= (20)(0.3)(0.005)$ $= 0.03$ Wb	1A	Accept equivalent unit : T m^2, Vs
$\xi = \frac{N\Delta\Phi}{\Delta t} = \frac{0.03}{0.5}$	1M	
$= 0.06$ V (or 60 mV)	1A 3	

(b)	(i)	The change of (magnetic) flux linkage is double that in (a)(ii), i.e. 0.06 Wb.	1M 1	e.c.f. from (a)(ii)
	(ii)	Direction of current : *PQRS*	1A 1	NOT accept Clockwise/anticlockwise

8

(c)	(i)		1A 1A 2	Correct position (accept just within the magnetic field) Correct direction (clockwise) with complete circular path inside the aluminium plate
	(ii)	Move/swing to the right initially/momentarily/briefly.	1A 1	

9

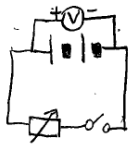
Thanks

10

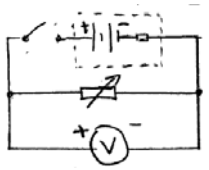
Candidates' response - 7(a)

Well answered

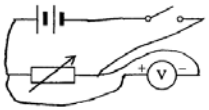
Circuit diagram



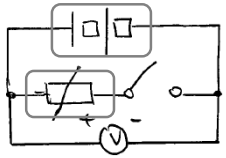
1A
1A



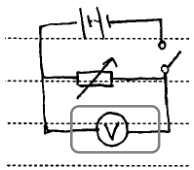
1A
1A



1A
1A



0A
1A



1A
0A

Candidates' response - 7(a)

Procedure

with reference to the diagram, you can see that the voltmeter is connected across the batteries. It is used to measure the terminal voltage V delivered by it. And when the switch is pressed, there is electrons flowing along the connecting wires, and by varing the resistance by the variable resistor (with several known resistance values R to be selected. By ohm's law, $R=\frac{V}{I}$

When R↑, I↑

0A
1A

12

Candidates' response - 7(a)

Procedure

a) Connect the voltmeter to the positive terminal of the battery. Make sure the resistance value of the variable resistor is ~~set~~ adjusted to the largest to prevent the overload of the circuit before ~~the~~ closing the switch.

Reduce the variable resistor to suitable resistance, the voltage of the voltmeter readings increase while the R decrease.

~~Enter~~ Calculate the ~~value~~ experiment result.

0A
1A

13

Candidates' response - 7(a)

Procedure + precaution

First connect the circuit as shown, then adjust the resistance of the resistor to a fixed known value, then close the switch and record down the voltage shown by the voltmeter. Repeat the procedure for at least 3 times with different fixed known resistance of resistor. Then plot a graph of V against R using the data produced, a curve will be produced, showing the relationship between terminal voltage V and resistance R. Do not close the circuit for too long, or else heating effect may occur and may lead to inaccurate voltage reading.

1A
1A
1A

14

Candidates' response - 7(a)

Precautions

Precaution: Open the switch before changing the value of R

1A

7a, Precaution: The resistance of the voltmeter should be very ~~R~~ larger compared to the maximum resistance of the ~~variable~~ variable resistor.

0A

Precautions that were not relevant to accuracy or safety of the experiment

注意事項：不要將伏特計的正極負極接到錯誤的電線上，如正極在接的電池正極

0A

15

Candidates' response - 7(b)

V is directly proportional to R.
$V = \varepsilon \times \frac{R}{R+r}$

0A
1A

V increases with R or decreases with R
$V = \varepsilon\left(\frac{R}{r+R}\right)$

0A
1A

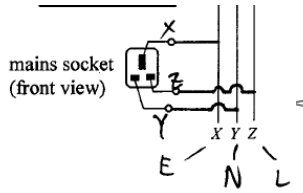
When R increases, V increases
$V = \varepsilon - Ir$
$I = \frac{V}{R}$
$\Delta V = \varepsilon - \frac{V}{R}(r)$

1A
0A

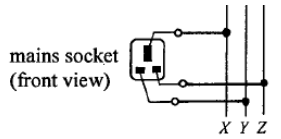
Incomplete

Candidates' response - 8(a)

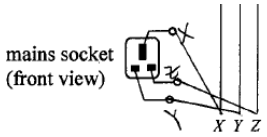
Well answered



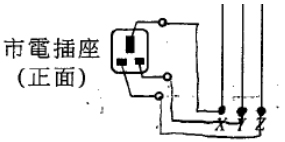
1A



1A



1A
(condoned)



0A

Candidates' response - 8(b)(i)

Well answered

Each branch does not affect each other so the broken of one branch will not affect the other.

1A

..... Such that when one lighting sets failed to function due to short circuit, the other can still work normally.

0A

確保 L_1 和 L_2 的電壓都是 220 V

1A

Candidates' response - 8(b)(ii)

Well answered

D8/1

$P = \frac{V^2}{R}$
$300 = \frac{220^2}{R_1}$
$R_1 = 161.33\ \Omega$

$P = \frac{V^2}{R}$
$480 = \frac{220^2}{R_2}$
$R_2 = 107.58\ \Omega$

1M
1A
1A

$P = I^2R$
$300+480 = I^2\left(\frac{1}{161.3} + \frac{1}{107.58}\right)^{-1}$
$I = 3.409$

Unit?

∴ 5A fuse is the most suitable

For L_1, $300 = I_1(220)$
$I_1 = 1.36A$
For L_2, $480 = I_{L2}(220)$
$I_{L2} = 2.18A$
∴ 3A fuse is most suitable

$R_{L_1} = \frac{220^2}{300} = 161\ \Omega$ (3sf)
$R_{L_2} = \frac{220^2}{400} = 121\ \Omega$
$R_{both} = \left(\frac{1}{161} + \frac{1}{121}\right)^{-1} = 69.1\ \Omega$ (3sf)

$V = IR$
$220 = I(69.1)$
$I = 3.18\ A$ (3sf)
∴ The normal working current is 3.18A, thus a 5A fuse should be used

1M
0A
1A

1M
0A
0A

Candidates' response - 8(c)

Well answered

$\frac{8\times3600\times500+0.5\times2000\times3600+3000\times3600\times2}{1000\times3600}\times0.9$

$=\$9.9$

\$9.9 should be paid per day to run these appliances if 1 kWh of electrical energy costs \$0.9.

1M
1M
1A

~~8×3600×500~~ ~~0.5×2000×3600~~ ~~3000×3600×2~~ ~~×0.9~~

Refrigerator $= 0.5\times8\times0.9 = \$75.6$

electric kettle $= 2\times0.5\times0.9 = 10.9$

Induction cooker $= 3\times2\times0.9 = 5.4$

Total $= 75.6 + 0.9 + 5.4$

$= \$81.9$

1M
1M
0A

$\left(\frac{500\times10^{-3}}{8}+\frac{2000\times10^{-3}}{0.5}+\frac{3000\times10^{-3}}{2}\right)\times0.9$

$= (0.0625 + 4 + 1.5)\times0.9$

$= \$5.00$

0M
0M
0A

20

Candidates' response - 9(a)(i)

As the strength of magnetic field is changing, according to Faraday's law, there is an induced emf of the coil.
As the coil forms a close and completed circuit, an induced current is formed.

1A
1A

According to lenz' law, a current is induced to oppose the change in magnetic flux, as the the magnetic field decreases constantly, a current is induced in the coil to oppose the decrease in magnetic flux.

0A
1A

A current would be induced as a complete circuit is formed. thus the turning moment will affect the strength of the magnetic field, ~~instant~~ induce current.

0A
0A

21

Candidates' response - 9(a)(ii)

magnetic flux linkage : $\Delta\phi = \Delta B \times A$

$= 0.3\times0.005$

$= 1.5\times10^{-3}\ Tm^{-2}$

0A
1M
1A

induced emf $\varepsilon = N\frac{\Delta\phi}{\Delta t}$

$= \frac{20\times1.5\times10^{-3}}{0.5}$

$= 0.06\ V$

$\Delta\phi = B\Delta A$

$= 0.3\times0.005$

$= 0.015$

$\varepsilon = N\frac{\Delta\phi}{\Delta t}$

$\varepsilon = 20\times\frac{0.005\times0.3}{0.5}$

$\varepsilon = 0.06\ (V)$

∴ 感生电动势为 0.06V.

The change in total magnetic flux linkage

$= 0.005\times20\times0.3 - 0$

$= 0.03\ (T)$

The induced emf ε in the coil

$= -\frac{\Delta\phi}{\Delta t}$

$= -\frac{0.03-0}{0.5}$

$= -0.06\ (V)$

0A
1M
1A

0A
1M
1A

22

Candidates' response - 9(b)(i)&(ii)

Not answered as well as would have been expected

The change in total magnetic flux linkage

$= 0.03\times2$

$= 0.06\ (T)$ Incorrect unit

1A (GMI-2)

The value of total magnetic flux linkage will become (change) double * it's a vector, * $0.06\times2 = 0.12V$ change in total magnetic flux linkage.

0A

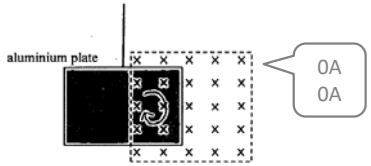
since the coil is parallel to the magnetic field No current induced.

0A

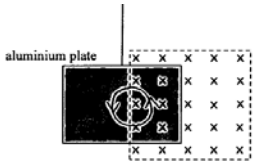
23

Candidates' response – 9(c)(i)

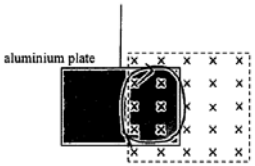
Poorly answered



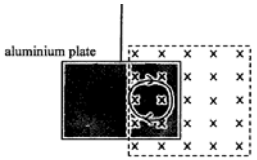
0A
0A



1A
0A



0A
0A



1A
1A

https://www.mechanicsandmachines.com/?p=489
https://phys.libretexts.org/Bookshelves/University_Physics/Book%3A_University_Physics_(OpenStax)

Candidates' response - 9(c)(ii)

The aluminium plate will move to the right a little and back to its original position.

1A

It will turn clockwise.

0A

鋁片會彈向前，之後返回原處

0A

銀着磁場未移動.

1A

2019 DSE PHYSICS Paper 1B

Q. 2, 4 &10

QUESTION 2(a)

*2. A weather balloon of volume 0.52 m^3 is filled with helium gas of temperature 15 °C and pressure 100 kPa at ground level.

(a) Find the amount of helium gas (in mol) in the balloon. (2 marks)

Suggested Marking Scheme	Performance/Common Errors
$pV = nRT$ $(100 \times 10^3)(0.52) = n\,(8.31)(273+15)$ [1M] $n = 21.727504\ (\text{mol}) \approx 21.7\ (\text{mol})$ [1A]	Some candidates forgot to convert the temperature given in Celsius to Kelvin scale. Some candidates mixed up the number of molecules with the number of moles.

QUESTION 2(a) (SAMPLES)

(a) Find the amount of helium gas (in mol) in the balloon. (2 marks)

Let n be the amount of gas (in mole)
$100 \cdot 0.52 = n \cdot 8.31 \cdot (15+273)$ ✓ 1M
$n = 0.0217$ mol ✗ 0A

Accept wrong order of magnitude of *p* for 'M' mark

By $pV = nRT$
$100 \times 10^3 \times 0.52 = n \times 8.31(15)$ ✓ 1M
$n = 417$ mol ✗ 0A

Accept *T* = 15 (∵ no 'A' mark in other parts using the value of *n* calculated)

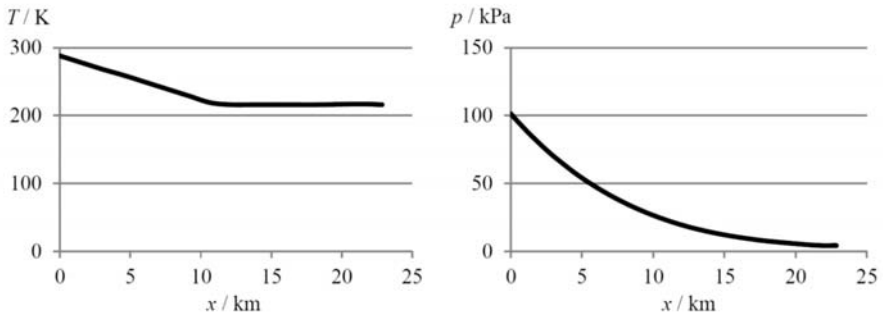
$pV = nRT$
$(100)(0.52) = n\,(8.31)(15+273)$ ✗
$n = 0.0217$
Amount of gas $= 0.0217 \div 6.02 \times 10^{23}$ 0M
$= 3.60 \times 10^{-26}$ mol ✗ 0A

***n* = no. of molecules ×**

$pV = nRT$
$n = \frac{RT}{pV} = \frac{8.31(273+15)}{100 \times 1000 \times 0.52}$ ✗
$= 0.0460$ mol ✗ 0M 0A

QUESTION 2(b)

(b) The following graphs show the variation of air temperature T and atmospheric pressure p with height x above ground level.



The weather balloon is released and rises to the upper atmosphere. Assume that the temperature and pressure of the helium gas in the balloon are the same as those of the air outside at any height x.

QUESTION 2(b)(i)

(i) A student believes that as the air temperature decreases in the first 10 km, the volume of the balloon decreases. Referring to the graphs above, explain qualitatively why this belief is not correct. (2 marks)

Suggested Marking Scheme	Performance/Common Errors
Since $pV = nRT \Rightarrow V = \frac{nRT}{p}$ / volume V of the balloon depends on both T and p, [1A] the (fractional) decrease in pressure p (with height) is greater / faster than the (fractional) decrease in temperature T. [1A]	Many candidates knew that the decrease in pressure would in effect increase the volume of the balloon. A few candidates were able to compare the change in pressure with the change in temperature while some wrongly thought that the volume remained unchanged.

QUESTION 2(b)(i) (SAMPLES)

(i) A student believes that as the air temperature decreases in the first 10 km, the volume of the balloon decreases. Referring to the graphs above, explain qualitatively why this belief is not correct. (2 marks)

As the temperature decreases
atmospheric pressure decreases ✓ more
significantly ✓ according to the graph 1A
therefore its volume increases 1A

Accept *T* decreases, *P* decreases
Accept decreases more significantly

Because the T and p is decrease ✓
that $\frac{pV}{T}$ = constant when p and T decrease
the V should be increase ✗ as $V \propto \frac{1}{\frac{p}{T}}$ 1A 0A

Accept *T* and *P* decrease

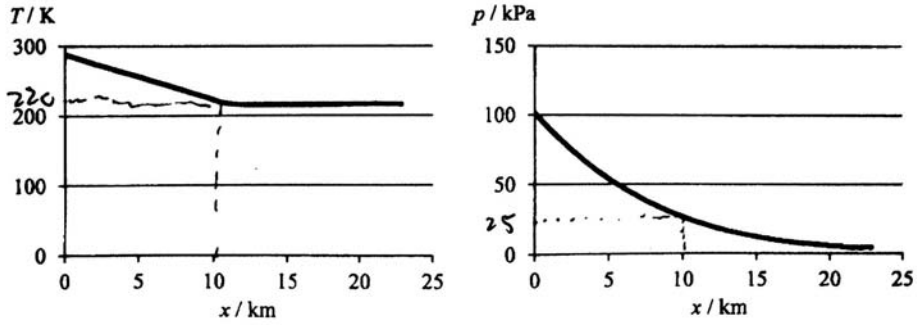
No mark for *V* increases

False. As by $pV = nRT$, as the balloon rises
above the ground level, its pressure in the
surroundings decreases, ✗ thus its volume
increases ✗ since the temperature in the 0A
balloon remains unchanged by Boyle's law. 0A

No mark for *P* decreases only
No mark for *V* increases

QUESTION 2(b)(i) (SAMPLES)

(i) A student believes that as the air temperature decreases in the first 10 km, the volume of the balloon decreases. Referring to the graphs above, explain qualitatively why this belief is not correct. (2 marks)



By $\frac{p_0V_0}{T_0} = \frac{pV}{T}$

$V = \frac{100V_0}{288} \times \frac{220}{25}$ ✓

$= 3.06\,V_0$ ✗

which shows the new volume is much larger than the original as the pressure decreased. 1A 0A

7

QUESTION 2(b)(ii) (1)(SAMPLES)

(ii) In fact the weather balloon keeps on expanding when it rises. The air temperature becomes steady at 216 K from a height of 12 km onwards. When the balloon rises further beyond 12 km and its volume reaches 8 m^3,

(1) estimate the gas pressure in the balloon; (2 marks)

$p(8) = nR(216)$

$8p = 0.0217R(216)$ ✓

$p = 4.868829$

$= 4.87$ kPa ✗ 1M 0A

Correct method, *n* from part (a) -- e.c.f. ✓

Answer from wrong *n* ×

$p_1V_1 = p_2V_2$

$0.52 \times 100000 = p_2 \times 8$ ✗ 0M

$p_2 = 6500$ Pa ✗ 0A

Assume constant *T* ×

$\frac{100\times1000\,(0.52)}{216} = \frac{p(8)}{15+273}$ ✗

$p = 8666.7$

$= 8.67$ kPa ✗ 0M 0A

9

QUESTION 2(b)(ii)(1)

(ii) In fact the weather balloon keeps on expanding when it rises. The air temperature becomes steady at 216 K from a height of 12 km onwards. When the balloon rises further beyond 12 km and its volume reaches 8 m^3,

(1) estimate the gas pressure in the balloon; (2 marks)

Suggested Marking Scheme	Performance/Common Errors
$\frac{pV}{T} = \text{constant}$ $\frac{(100)(0.52)}{(273+15)} = \frac{p(8)}{216}$ [1M] $p = 4.875$ kPa or 4875 Pa [1A]	Well answered. Some candidates considered the temperature to be constant and wrongly used Boyle's law to estimate the pressure.

8

QUESTION 2(b)(ii)(2)

(2) hence find the corresponding height reached by the balloon. The variation of atmospheric pressure p with height x (in km) is given by

$$p = p_0e^{-kx},$$

where p_0 is the atmospheric pressure at ground level and $k = 0.138$ km^{-1}. (2 marks)

Suggested Marking Scheme	Performance/Common Errors
$p = p_0e^{-kx}$ $4.875 = 100\,e^{-0.138x}$ [1M] $x = 21.89166726$ (km) ≈ 21.9 (km) [1A]	A few made mistakes when converting units or wrongly took the base e of the exponential function as the electronic charge.

10

QUESTION 2(b)(ii) (2)(SAMPLES)

(2) hence find the corresponding height reached by the balloon. The variation of atmospheric pressure p with height x (in km) is given by

$$p = p_0 e^{-kx},$$

where p_0 is the atmospheric pressure at ground level and $k = 0.138$ km^{-1}. (2 marks)

$4875 = 100000\ e^{-0.138x}$ ✓

$\log 4875 = \log 100000 + -0.138x \log e$

$\dfrac{\log 4875 - \log 100000}{\log e} = -0.138\ x$

$\dfrac{\frac{4875}{100000}}{e} = -0.138\ x$

$x = 30.2$ km ✗

1M
0A

$p = p_0\ e^{-kx}$

$4869 = (100 \times 1000)(1.6 \times 10^{-19})^{-0.138x}$ ✗

$\log 0.04869 = (-0.138x)(\log 1.6 \times 10^{-19})$

$x = 0.506$ km ✗

1M
0A

$p = 4870\ e^{-(0.138) \times (24)}$ ✗

$= 177$ Pa ✗

0M
0A

QUESTION 4(a)(i)

*4. (a)

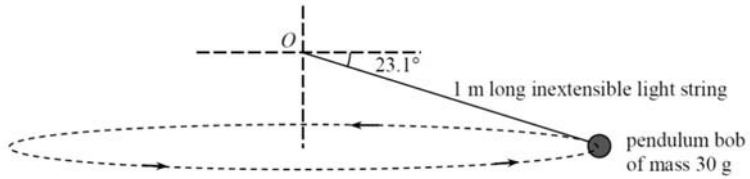


Figure 4.1

A pendulum bob of mass 30 g is tied to a fixed point O by a 1 m long inextensible light string. It is swirled to describe a horizontal circle uniformly at an angular velocity of 5.0 rad s^{-1} as shown in Figure 4.1. Neglect air resistance. ($g = 9.81$ m s^{-2})

(i) What is the bob's rotation rate (in revolutions per second) ? (1 mark)

Suggested Marking Scheme	Performance/Common Errors
Rotation rate $= \dfrac{\omega}{2\pi} = \dfrac{5.0}{2\pi}$ [1A/1M] $= 0.795775$ (rev s^{-1}) ≈ 0.80 (rev s^{-1})	Many candidates had difficulties in relating the angular velocity with the rotation rate.

QUESTION 4(a)(i) (SAMPLES)

(i) What is the bob's rotation rate (in revolutions per second) ? (1 mark)

5 rad s^{-1}

$\dfrac{5 \times 180}{\pi} = 286.4°$ s^{-1}

$= 0.8$ revolution s^{-1} ✓

1A

$r = 1 \cos 23.1 = 0.92$ m

$2\pi r = 5.78$ m

$\dfrac{5}{5.78} = 0.885$ ✗

0M

Consider angular velocity to be the speed ×

Bob complete 5 revolutions per second. ✗

0A

Rotation rate : $\dfrac{1}{5}$ ✗

$= 0.2$ revolutions/s

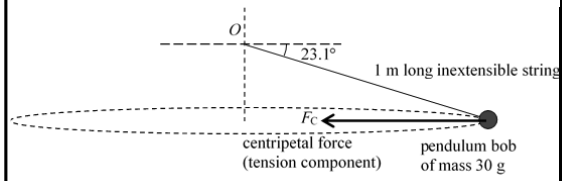
0M

$T = \dfrac{2\pi}{5} = 1.26$ ✗

0M

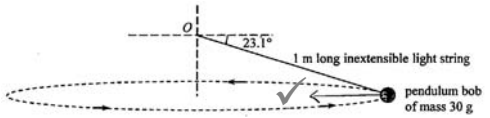
QUESTION 4(a)(ii)

(ii) Indicate on Figure 4.1 the centripetal force F_C required for the motion of the bob. Find F_C. (3 marks)

Suggested Marking Scheme	Performance/Common Errors
 F_C correctly indicated. [1A] $F_C = mr\omega^2$ $= (0.03)(1 \times \cos 23.1°)(5.0)^2$ [1M] $= 0.689866$ N ≈ 0.690 N [1A] ($F_C = 0.7033402$ N ≈ 0.703 N for $g = 10$ m s^{-2})	Most of the candidates were able to find the centripetal force. A few candidates did not indicate F_C in the figure or mistook the length of the string to be the radius.

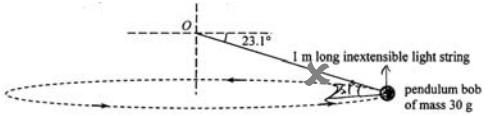
QUESTION 4(a)(ii) (SAMPLES)

(ii) Indicate on Figure 4.1 the centripetal force F_C required for the motion of the bob. Find F_C. (3 marks)



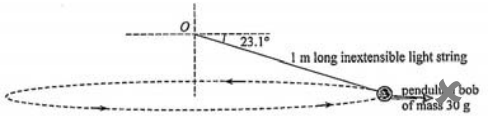
1A

Accept 1 arrow without label

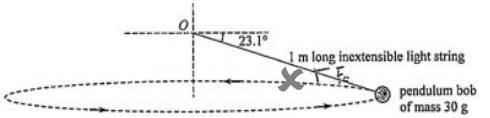


0A

2 arrows without labels ×



0A



0A

QUESTION 4(a)(ii) (SAMPLES)

(ii) Indicate on Figure 4.1 the centripetal force F_C required for the motion of the bob. Find F_C. (3 marks)

By $\frac{F_c}{\sin\theta} = \frac{mg}{\cos\theta}$ ✓
$F_c = (0.03)(9.81)\tan 66.9°$ 1M
$= 0.690$ N (towards centre of circular path) 1A

Accept any correct method to find F_c

$\tan(90° - 23.1°) = \frac{r(5)^2}{9.81}$ $F_c = (0.3)(0.92)(5)^2$ ✓
$r = 0.920$ m $= 6.9$ N ✗ 1M 0A

Wrong order of magnitude of *m* ✓

$F_c = ma = m\frac{v^2}{r} = (0.03)\frac{5^2}{\cos 23.1°}$ ✗
$= 0.815$ N ✗ 0M 0A

$F = mr\omega^2$ ✗
$= (30 \div 1000)(1)(5)^2$ 0M
$= 0.75$ N ✗ 0A

$F_c = m\omega^2 r$ ✗
$= (0.3)(1\cos 23.1°)(5\times 2\pi)^2$ 0M
$= 272.35$ N ✗ 0A

QUESTION 4(a)(iii)

(iii) Explain whether the magnitude of the tension in the string is greater than, equal to or smaller than the centripetal force F_C found in (a)(ii). (2 marks)

Suggested Marking Scheme	Performance/Common Errors
Horizontal component of tension provides the centripetal force, thus tension is larger than the centripetal force. [1M] [1A] OR $T\cos\theta = F_C \Rightarrow T > F_C$	A majority of the candidates tackled this part by finding out the value of the tension. Weaker candidates believed that the tension was the resultant of the bob's weight and the centripetal force.

QUESTION 4(a)(iii) (SAMPLES)

(iii) Explain whether the magnitude of the tension in the string is greater than, equal to or smaller than the centripetal force F_C found in (a)(ii). (2 marks)

greater than ✓
since the tension provides F_c and overcome ✓ 1M
the weight of the pendulum bob. 1A

2 components of *T* ✓

$T\cos 66.9° = mg$ ✓
$T = 0.076$ N $< F_c = 0.69$ N 1M
$\therefore$ smaller than F_c ✗ 0A

Accept any correct method to find *T*

Tension is greater. It is the resultant ✗ 0M
of F_c and the weight of the bob ✗ 0A

Correct answer with wrong explanation ×

Magnitude of tension in the is greater than the centripetal force F_c ✗
∵ The length of the string is larger than the distance 0M
between the bob and the centre of the circular path. ✗ 0A

Correct answer with wrong explanation ×

$T = W = 0.2943$ N ✗
By $T = W = mg$, the tension of the string is equal to
the weight of the object. The tension is smaller than ✗ 0M
centripetal force. 0A

QUESTION 4(b)(i)

(b) The moon is orbiting around the Earth uniformly in a circular path under the influence of the Earth's gravitational attraction.

(i) Explain why the speed of the moon remains unchanged although it is acted upon by gravitational force. (2 marks)

Suggested Marking Scheme	Performance/Common Errors
The gravitational force is perpendicular to the moon's motion/velocity, [1A] thus no work is done on the moon by this force (k.e. unchanged) [1A]	Some candidates failed to point out that no work is done by the gravitational force acting on the Moon while weaker ones failed to realise that the centripetal force is actually the gravitational pull and stated that the net force acting on the Moon is zero.

QUESTION 4(b)(i) (SAMPLES)

(b) The moon is orbiting around the Earth uniformly in a circular path under the influence of the Earth's gravitational attraction.

(i) Explain why the speed of the moon remains unchanged although it is acted upon by gravitational force. (2 marks)

The speed of moon is perpendicular to the gravitation force. No work is done to the moon such that it remains a constant speed. — 0A / 1A

direction of speed ×

The gravitational force acted on moon is balanced, thus there is no net force acted on the moon so the moon undergo uniform motion. — 0A / 0A

For uniform circular motion, $\frac{GMm}{r^2} = \frac{mv^2}{r}$

$v = \sqrt{\frac{GM}{r}}$ ∴the speed remains unchanged. — 0A / 0A

The gravitational force only changes its direction, Therefore the velocity of the moon is constantly changes, but the speed doesn't change. — 0A / 0A

QUESTION 4(b)(ii)

(ii) A student claimed that as the moon is much less massive than the Earth, it exerts negligible force on the Earth. Comment on the student's claim. (2 marks)

Suggested Marking Scheme	Performance/Common Errors
(The claim is incorrect) as, by Newton's third law of motion, gravitational force of the same magnitude (but in opposite direction) is acting on the Earth by the moon. [1A] [1A]	Most of the candidates were able to mention an action-and-reaction pair or use Newton's Law of Gravitation to explain.

QUESTION 4(b)(ii) (SAMPLES)

(ii) A student claimed that as the moon is much less massive than the Earth, it exerts negligible force on the Earth. Comment on the student's claim. (2 marks)

The force between the moon and the earth acts as an action and reaction pair. Although the moon is much less massive than the earth, there is also a force exerts on the Earth by moon. — 1A / 0A

Action-reaction pair ✓

The claim is wrong.
The force acting on Earth by moon equals to The force acting on Moon by Earth. — 0A / 1A

No, as the force is due to the gravitational force which is $\frac{GMm}{r^2}$, both earth and moon experiences force from each other. — 1A / 0A

gravitation force (on moon & Earth) = G*Mm*/r² ✓

correct. $\frac{GMm}{r^2}$ where M is the mass of Earth and m is the mass of the moon. m is much smaller than M and hence the difference between $\frac{GM}{r^2}$ and $\frac{GMm}{r^2}$ is not big. — 0A / 0A

QUESTION 10(a)(i)

10. (a) The equation below represents nuclear fission of uranium-235 (U-235).

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + x\,{}^{1}_{0}\mathrm{n} + 200\ \mathrm{MeV}$$

(i) What is the value of x ? (1 mark)

Suggested Solution	Common Errors
$x = 3$ [1A]	**Well answered**

QUESTION 10(a)(i) (SAMPLES)

$x = 235 + 1 - 141 - 92 = 3$ ✓	1A
$235 + 1 - 141 - 92 - 1 = 3$ ✗	0A
$235 - 141 - 92 = 2$ ✗	0A
3 ✓	1A

Answer from wrong equation ×

QUESTION 10(a)(ii)

(ii) State a necessary condition for chain reaction of fission to occur. (1 mark)

Suggested Marking Scheme	Performance/Common Errors
More neutrons are produced in each fission for triggering further fissions, i.e. $x > 1$. [1A]	Not many candidates gave the crucial condition that the number of neutrons produced in fission must be greater than 'one' for a chain reaction to be sustained. Weaker candidates may have thought that slow neutrons had to be the products of the fission reaction.

QUESTION 10(a)(ii) (SAMPLES)

(ii) State a necessary condition for chain reaction of fission to occur. (1 mark)

Neutrons are emitted ✓	1A
There is neutron generated after each nuclear fission of particle. ✗	0A
There are abundant uranium-235 ✓	1A
The neutron is slow. ✗	0A
A fast moving neutron has a collision with the uranium. ✗	0A
The reaction chamber must be in very high temperature and uranium-235 nucleus must capture the neutron. ✗	0A
Very high pressure ✗	0A

Neutrons ⇒ more than 1 neutron ✓

Assume > critical mass after each fission ✓

QUESTION 10(b)(i)

Scientists found evidence in Oklo, Africa that natural nuclear fission occurred two billion (2×10^9) years ago. The uranium mineral ore mined from Oklo **at present** is found to have 0.6% concentration by mass of U-235 (see the table below), which is much lower than usual.

(b) The table gives the information of U-235 and U-238 in a sample of uranium mineral ore found in Oklo.
Given: half-life of U-235 = 7.04×10^8 years

	2×10^9 years ago	at present
U-235	m_0 kg	0.060 kg (i.e. 0.6% concentration by mass)
U-238	13.556 kg	9.940 kg (i.e. 99.4% concentration by mass)

*(i) Estimate the amount m_0 (in kg) of U-235 in the sample 2×10^9 years ago. (2 marks)

Suggested Marking Scheme	Performance/Common Errors
$m = m_0 e^{-kt}$ $k = \dfrac{\ln 2}{t_{1/2}} = 9.846 \times 10^{-10}\ \mathrm{yr}^{-1}$ $0.06 = m_0\, e^{-\ln 2 \times \left[\frac{2\times10^9}{7.04\times10^8}\right]}$ [1M] $m_0 = 0.429882832\ (\mathrm{kg}) \approx 0.430\ (\mathrm{kg})$ [1A]	Most of the candidates managed to find the amount of U-235 in the sample.

QUESTION 10(b)(i) (SAMPLES)

*(i) Estimate the amount m_0 (in kg) of U-235 in the sample 2×10^9 years ago. (2 marks)

The amount $= \dfrac{0.06}{0.5\left(\frac{2\times10^9}{7.04\times10^8}\right)}$ ✓
$= 0.0430$ kg ✗ 1M 0A

Accept any correct method with correct substitution

Half life that U-235 has experienced
$= \dfrac{2\times10^9}{7.04\times10^8} \approx 2.809 \approx 3$ half lives ✓ 1M
$m_0 = 0.06 \times 2^3 = 0.48$ kg ✓ 1A

Accept no. of half-lives = 3

$\dfrac{0.06}{m_o} \times 100\% = 0.6\%$ ✗
$\dfrac{0.06}{m_o} = 6 \times 10^{-3}$
$m_o = 10$ kg ✗ 0M 0A

Present mass and concentration of U-235 was used -- total mass at present was calculated

$\dfrac{13.556}{9.94\%} \times 0.6\%$ ✗
$= 0.0818$ kg ✗ 0M 0A

Present concentrations of U-238 & U-235 were used to find the total mass & m_0 respectively

QUESTION 10(b)(ii)

(ii) Hence determine whether natural nuclear fission of U-235 was possible 2×10^9 years ago. For fission of U-235 to happen, its concentration by mass in the uranium mineral ore has to be at least 3%. (1 mark)

Suggested Marking Scheme	Performance/Common Errors
$\dfrac{0.430}{13.556+0.430} = 0.03073691 \approx 3.1\% > 3\%$ [1M/1A] Thus natural nuclear fission was possible.	Many candidates could not obtain the correct value of the concentration by mass.

QUESTION 10(b)(ii) (SAMPLES)

(ii) Hence determine whether natural nuclear fission of U-235 was possible 2×10^9 years ago. For fission of U-235 to happen, its concentration by mass in the uranium mineral ore has to be at least 3%. (1 mark)

$\dfrac{0.42988}{13.556} \times 100\% = 3.17\% > 3\%$ ✓ 1M

Accepted mass of U-238 ≈ total mass

Concentration $= \dfrac{m_o}{\frac{0.06}{0.6\%}} \times 100\%$ ✗
$= \dfrac{0.430}{10} \times 100\%$
$= 4.30\% > 3\%$ ∴ Yes, it was possible. 0M

Total mass at present used to calculate the concentration ×

Critical mass $= 0.06 \div 0.6\% \times 3\% = 0.3$ kg ✗
< 0.430 kg 0M

Total mass at present used to calculate the critical mass ×

$0.03 = \left(\dfrac{1}{2}\right)^{\frac{t}{2\times10^9}}$ ✗
$t = 1.01 \times 10^{10}$ 年
須年過 1.01×10^{10} 年才能達 3%
∴ 裂變未能增生 0M

QUESTION 10(c)

There must be underground water in the vicinity of this uranium-rich mineral deposit for natural nuclear fission to be possible. Since water can slow down the fast neutrons from fission, these neutrons can easily be captured by U-235.

(c) In fact the chain reaction stopped even before the concentration by mass of U-235 dropped to 3%. Explain why this occurred. (2 marks)

Suggested Marking Scheme	Performance/Common Errors
Underground water might run dry. OR Energy released by fission drys up the underground water. [1A] Therefore, fission might stop without slow neutrons. [1A]	Poorly answered. Very few candidates were able to relate the energy of fission with the dry up of underground water, which led to a ceasing of the supply of slow neutrons. Wrong answers included: The neutrons were not energetic enough or the concentration of the fuel was not high enough.

QUESTION 10(c) (SAMPLES)

(c) In fact the chain reaction stopped even before the concentration by mass of U-235 dropped to 3%. Explain why this occurred. (2 marks)

The water is evaporated due to the intense heat Given out. No water was there to slow down the fast electrons.	1A 0A
There is no or little underground water in the area. No slow neutrons to start the chain reaction.	0A 1A
As water cool down the environment, no more nuclear fission can undergo. Since no neutron releases, chain reaction stops.	0A 0A
The speed of neutrons may not be fast enough and hence do not have sufficient energy for the chain reaction to occur.	0A 0A
Although the neutrons moved slowly, the U-235 is not concentrated enough and hard for neutrons to hit it and have a chain reaction.	0A 0A

Accept evaporated / decreases

No water/Little water ×

31

Thank You!

32

Paper 2

Section A: Astronomy and Space Science

Q.1 Multiple-choice questions

	A	B	C	D	
1.1	37.2	16.9	15.2	**29.3***	✓
1.2	11.3	**71.5***	10.0	5.4	
1.3	31.2	**47.2***	14.1	5.2	✓
1.4	**53.3***	12.2	22.9	9.7	
1.5	11.3	16.2	17.7	52.6*	
1.6	**51.2***	8.9	10.3	27.5	
1.7	16.4	11.4	**21.2***	48.3	✓
1.8	12.8	14.8	**39.3***	30.3	✓

*** : key** ; Red colour : most favourable distractor

MCQ 1.1

1.1 The size of atomic nucleus is of the order of 10^{-14} m. The size of cluster of galaxies is of the order of 10^{6} pc. The volume ratio of an atomic nucleus to a cluster of galaxies is about _____ .

A.	10^{-37}	favourable distractor	37.16%	A	B	C	D
B.	10^{-60}			○	○	○	○
C.	10^{-74}						
* D.	10^{-111}		29.31%				

$R_a \approx 10^{-14}$ m

$R_G \approx 10^6$ pc $\approx 10^6$ x 3.09 x $10^{16} \approx 3.09$ x 10^{22} m

$$\frac{V_a}{V_G} \approx \frac{(R_a)^3}{(R_G)^3} \approx \frac{(10^{-14})^3}{(3.09\times10^{22})^3}$$

MCQ 1.3

1.3 Rigel is a star 260 pc from the Sun. What is the shift in angle on photographs of Rigel taken six months apart ?

A.	0.0038″	favourable distractor	31.20%	A	B	C	D
*B.	0.0077″		47.16%	○	○	○	○
C.	130″						
D.	260″						

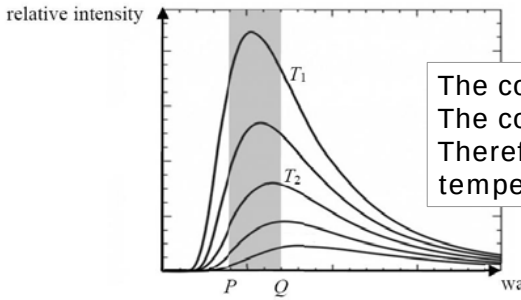
$d = 260$ pc

$$p = \frac{1}{260} = 3.846 \times 10^{-3} \text{ arcseconds (″)}$$

Angle shift = 2 p = 0.0077″

MCQ 1.7

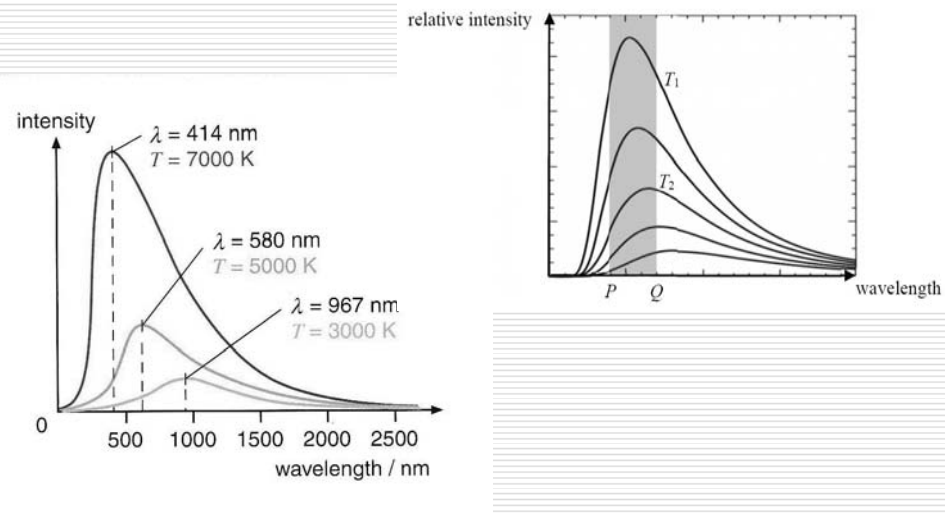
1.7 The figure below shows the radiation curves from different stars.



The colour of T_1 about yellow.
The colour of T_2 about red.
Therefore T_1 is the Sun's temperature

P and Q denote the lower and upper wavelength limits of the visible spectrum respectively. T_1 and T_2 are temperatures of the respective radiation curves with one of them belonging to the Sun. Which of the following is correct ?

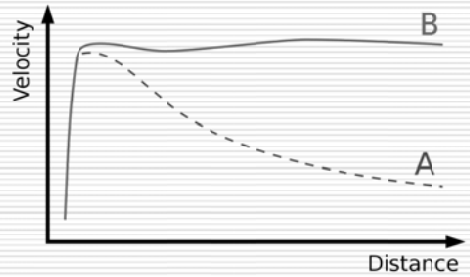
A.	P = red; Q = violet; T_1 is the Sun's temperature		
B.	P = red; Q = violet; T_2 is the Sun's temperature		
* C.	P = violet; Q = red; T_1 is the Sun's temperature		21.19%
D.	P = violet; Q = red; T_2 is the Sun's temperature	favourable distractor	48.31%



MCQ 1.8

1.8 What can we infer about the location of dark matter from the rotation curve of galaxies in the figure below ?

A. Dark matter is mainly distributed near the galactic centre.
B. Dark matter is distributed uniformly throughout the galaxy.
* C. Dark matter is distributed more at a large distance from the galactic centre. 39.30%
D. The rotation curve suggests dark matter exists but does not give us information about its distribution. favourable distractor 30.27%



Rotation curve of a typical spiral galaxy: predicted (A) and observed (B).
Dark matter can explain the 'flat' appearance of the velocity curve out to a large radius.

Q.1 Structured question

Figure 1.1 shows a space station *S* revolving in a circular orbit at a height of 400 km **above** the Earth's surface.

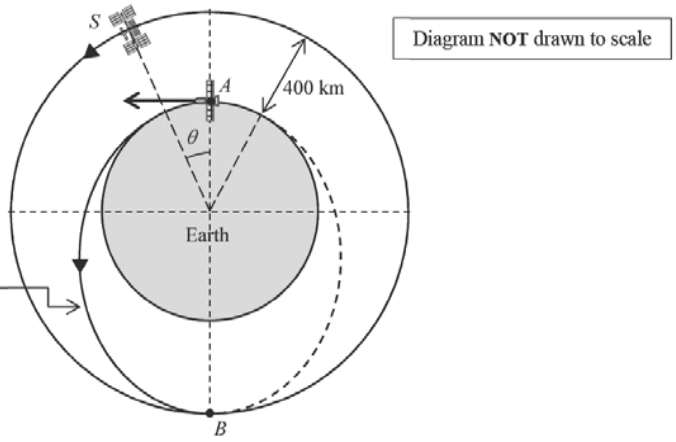


Figure 1.1

A spacecraft is launched with speed 8.02 km s^{-1} from *A* at the Earth's surface to meet the station *S* through an elliptical orbit with *AB* as the major axis. The spacecraft's rocket engine is shut when it coasts from *A* to *B* along the elliptical orbit. Assume that the two orbits are in the same plane.
Given: $GM = 4 \times 10^5$ km^3 s^{-2}, where *G* is the universal gravitational constant and *M* is the mass of the Earth.
Radius of the Earth = 6400 km

(a) (i) Using conservation of total mechanical energy, or otherwise, find the speed v_B of the spacecraft when it reaches *B*. Neglect the effects of the atmosphere. (2 marks)

$$\frac{1}{2}m(v_B^2 - v_A^2) = GMm\left(\frac{1}{r_B} - \frac{1}{r_A}\right)$$

$$\frac{1}{2}m(v_B^2 - 8.02^2) = GMm\left(\frac{1}{6400+400} - \frac{1}{6400}\right)$$

$$v_B = 7.55 \text{ km s}^{-1}$$

1M Correct sub. for v_A , r_A and r_B
1A

Most candidates knew how to find the speed of the spacecraft at *B* using conservation of total mechanical energy though a few made mistakes in units conversion.

Q.1 Structured question

(ii) Show that the spacecraft takes about 2663 s to travel from *A* to *B*. (2 marks)

$$T^2 = \frac{4\pi^2 a^3}{GM}$$

$$T = 2\pi\sqrt{\frac{a^3}{GM}} \quad \text{where } a = \frac{r_A + r_B}{2}$$

1M: Correct expression for Kepler's 3rd law

$$a = \frac{r_A + r_B}{2} = \frac{(6400) + (400 + 6400)}{2}$$

$$= 6600 \text{ km}$$

1M: Correct semi-major axis

$$T_{AB} = \frac{T}{2} = \frac{1}{2}\left\{2\pi\sqrt{\frac{6600^3}{4\times 10^5}}\right\} = 2663.3962 \text{ s} \approx 2663 \text{ s}$$

Some candidates failed to answer (a)(ii) correctly as they did not know that the semi-major axis of the elliptical orbit should be employed in the calculation

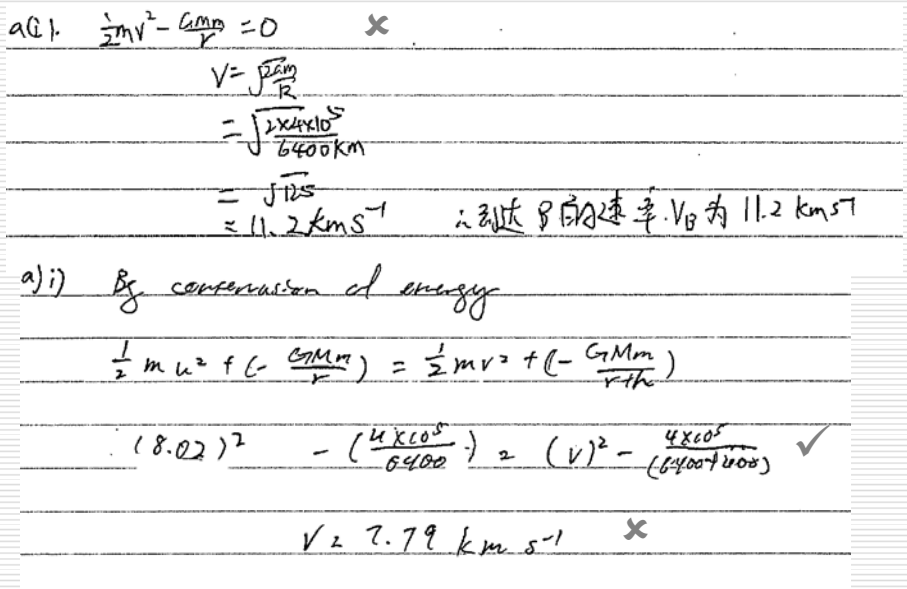
Q.1 Structured question

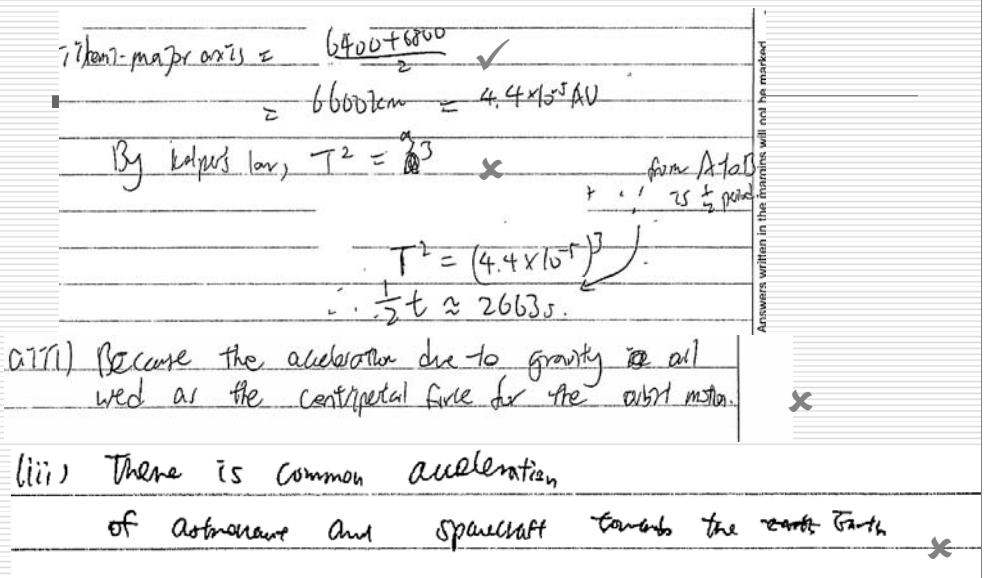
(iii) Explain why an astronaut in the orbiting spacecraft would experience 'weightlessness'. (1 mark)

Any one:
- The gravitational force acting on the astronaut is (all) used for accelerating the astronaut.
- The astronaut and the spacecraft are under the same acceleration due to gravity
- The gravitational force (weight) acting on the astronaut is used for centripetal force

NOT accept:
- They have the same acceleration
- The acceleration of gravity is used for centripetal force

Not many were able to explain the 'weightlessness' phenomenon in (a)(iii). A few had a misconception that both the astronaut and the spacecraft moving at the same acceleration would necessarily result in weightlessness.





Q.1 Structured question

(b) The space station S travels at a constant speed of 7.67 km s^{-1} in the circular orbit with a period of 5570 s.

(i) If the spacecraft is to meet the station S exactly when it reaches B, use the result in (a)(ii) to show that their angular separation θ (shown in Figure 1.1) when the spacecraft has just launched at A should be slighty less than 8°. (2 marks)

$$\theta = \frac{\frac{5570}{2} - 2663}{5570} \times 360° = 7.8850987° \approx 7.89°$$ 1 M ; 1A

Quite a number of the candidates managed to find the angular separation θ required in (b)(i) using various methods.

Q.1 Structured question

(ii) In order to make the spacecraft's speed v_B found in (a)(i) exactly the same as that of the station S when they meet at B, a student suggests to slightly adjust the launching speed of the spacecraft at A. Comment on the feasibility of the suggestion. (2 marks)

If the launching speed at A is slightly higher (or lower), the length of the elliptical orbit's major axis will be longer (or shorter). 1A
Thus the two orbits will no longer touch at B. 1A

Accept:
The shape of the spacecraft's orbit will be changed. Thus two orbits cannot meet at B.

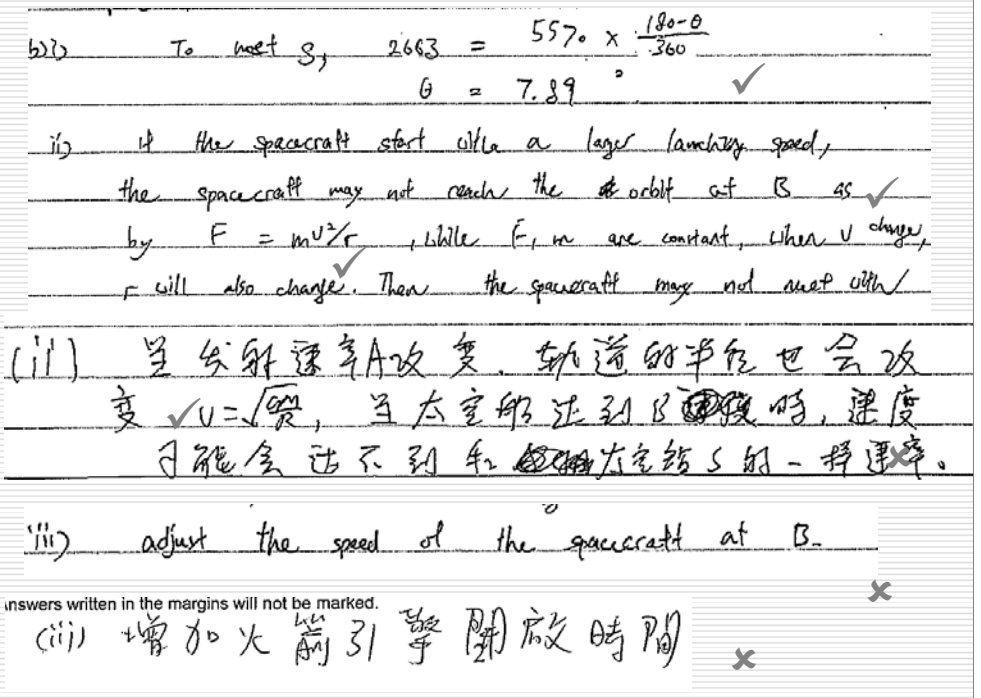
Q.1 Structured question

(iii) Suggest one simple way for the spacecraft at B to travel with the same speed as station S. (1 mark)

The spacecraft has to fire its rocket briefly at B so as to boost up its speed to the required speed. 1A
(i.e. from 7.55 km s^{-1} to 7.67 km s^{-1})

NOT accept: - change the speed
- start the engine

Poorly answered. It seemed that most candidates did not know that the initial launching speed of the spacecraft at the Earth's surface would eventually determine the shape of its trajectory



Paper 2

Section C : Energy and Use of Energy

Q.3 Multiple-choice questions

	A	B	C	D	
3.1	8.4	**63.7***	19.6	8.2	
3.2	2.0	**77.5***	6.3	14.2	
3.3	**31.0***	7.3	49.3	12.4	✓
3.4	6.4	17.9	16.8	**58.8***	
3.5	22.4	37.9	13.0	**26.6***	✓
3.6	**72.5***	7.5	3.2	16.8	
3.7	12.4	4.4	**81.3***	1.8	
3.8	10.9	18.8	**52.0***	18.2	

*** : key** ; Red colour : most favourable distractor

MCQ 3.3

3.3 Which of the following descriptions about a hybrid car is/are correct ?

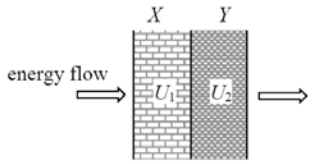
(1) The motor and the combustion engine of a hybrid car can be turned on at the same time to drive the car.
(2) A hybrid car is said to be environmental friendly as it does not emit pollutants directly.
(3) If the battery of a hybrid car cannot be charged via a wall socket, it can only be charged through the regenerative braking system during deceleration.

* A.	(1) only	30.94%	A	B	C	D
B.	(2) only		○	○	○	○
C.	(1) and (3) only favourable distractor	49.33%				
D.	(2) and (3) only					

Candidates do not know that a hybrid car can recharge its batteries through the regenerative braking system or while driving on engine power.

MCQ 3.5

3.5



A wall is composed of layers X and Y of U-values U_1 and U_2 respectively. Both layers have the same thickness and dimensions, and there is no air gap between them. Which expression gives the U-value of the wall ?

A.	$U_1 + U_2$	
B.	$\frac{1}{2}(U_1+U_2)$ favourable distractor	37.84%
C.	$\frac{2U_1U_2}{U_1+U_2}$	
* D.	$\frac{U_1U_2}{U_1+U_2}$	26.55%

$$\frac{Q}{t} = UA\Delta T = U_1 A\Delta T = U_2 A\Delta T$$

$$\Delta T = \Delta T_1 + \Delta T_2$$

$$\frac{1}{U} = \frac{1}{U_1} + \frac{1}{U_2}$$

Candidates do not understand the definition of U-value.

Q.3 Structured question

(a) The total power of the Sun is about 3.86×10^{26} W, which radiates evenly in all directions. The Earth is at a mean distance of 1.50×10^{11} m from the Sun.

(i) Estimate the solar radiation power per unit area that can be obtained at the same distance of the Earth from the Sun. (2 marks)

$$P_0 = \frac{P_S}{4\pi R_0^2} = \frac{3.86\times10^{26}\ \text{W}}{4\pi(1.50\times10^{11})^2\ \text{m}^2}$$ 1M

= 1.365195734 × 10^3 W m^{-2} ≈ 1365 W m^{-2} 1A

Accept: 1360 – 1370 W m^{-2}

Part (a)(i) was in general well answered. Some candidates failed to realise that the power of the Sun distributes evenly on a spherical surface according to the inverse square law.

Required power per unit area

$= \frac{3.86\times10^{26}}{\pi(1.50\times10^{11})^2}$ ✗

$= 5460\ \text{W m}^{-2}$ ✗ (to 3 sig. fig.)

$3.86\times10^{26} \div 1.50\times10^{11}$ ✗

$\approx 2.57\times10^{15}$ J ✗ per unit area ✗

$3.86\times10^{26} \div [4\pi(1.5\times10^{11})^2]$ ✓

$= 3.86\times10^{26} \div 9\times10^{22}\pi$

$= 1365$ W

最每單位面積功率為 1365 w ✗

Q.3 Structured question

(ii) State a reason why the maximum solar radiation power per unit area received on the Earth's surface normal to the Sun is only around 70% of that found in (a)(i). (1 mark)

Loss due to absorption by the atmosphere. 1A

Accept:
absorption / reflection / scattering by ozone layer

In (a)(ii), quite a number of the candidates were unable to account for the energy loss of the solar radiation power through the atmosphere.

Because some solar radiation is blocked when passing through the Earth's atmosphere ✓

因為部份太陽輻射被大氣層阻隔 ✓。

Some of the energy is absorbed by the dust ✗ particles in the space and some is absorbed the ✓ atmosphere.

Since some of the solar light is reflected away from the Earth by the atmosphere, ✓ and cannot reach the solar power panels.

Q.3 Structured question

(b) In the domestic energy storage system shown in the simplified schematic diagram below, energy from the Sun reaching a solar panel can be stored in a battery.

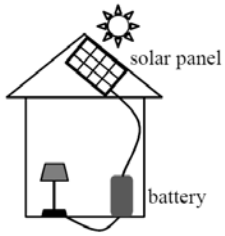


Figure 3.1

The solar panel of area 1.65 m^2 is connected to the battery via a charger controller (not shown in Figure 3.1). The solar panel delivers 300 W when it is normal to the Sun on a sunny day. Given: solar radiation power per unit area received on the Earth's surface = 1000 $W\ m^{-2}$

Q.3 Structured question

(i) Describe the energy conversions during charging in this domestic energy storage system. (2 marks)

Solar energy → electrical energy → chemical energy 1A 1A

NOT accept:
light and heat energy → electrical energy
light → electricity

Not many managed to describe the energy conversions in (b)(i) correctly. Some wrongly thought that it was electrical energy instead of chemical energy being stored in the battery while a few believed that heat or heat and light energy were being converted by the solar panel.

Solar energy is received by the solar panel. Then the solar energy is changed into electrical energy ✓ by the solar panel and transfer to the battery for storage ✗

太陽能轉為化學能轉為电能 ✗

把光能轉換成化學能 ✓

(b)(i)、太阳能板接收太阳辐射，将太阳的热能转换为电能，再将电能运送至电池组，转换为电池组中的化学能。✓

Q.3 Structured question

(ii) Find the efficiency of the solar panel. (2 marks)

$$\eta = \frac{\text{power output}}{\text{solar power input}} \times 100\%$$

$$= \frac{300}{1000 \times 1.65} \times 100\% \quad \text{1M}$$

$$= 18.1818\ \% \approx 18.2\ \% \quad \text{1A}$$

Most managed to find the efficiency of the solar panel in (b)(ii).

1000 × 1.65 × efficiency = 300 ✓

efficiency ≈ 18.2 % (cor. to 3 sig. fig.) ✓

ii) 300W / 1000W ✗

= 30%.

(ii) = 300/1000 × 100% ✗

= 30% ✗

∴ 效率為 30%

Q.3 Structured question

(iii) The capacity of the storage battery is '100 Ah 12 V'. How long would it take for the solar panel to fully charge the battery, which is completely discharged initially, if 20% energy loss occurs during charging ? State one assumption in your calculation. (3 marks)

$$t = \frac{\text{totalenergystored}}{\text{powerinput}}$$

1M for $\frac{100\ \text{Ah} \times 12\ \text{V}}{300\ \text{W}}$

$$= \frac{100\ \text{Ah} \times 12\ \text{V}}{300\ \text{W} \times 0.8}$$ 1M

= 5 hours 1A

The sun rays are (always) normal to the panel
Or Clear sky / not cloudy. 1A

Candidates' performance in (b)(iii) was fair. Some candidates did not realise that the capacity '100 Ah 12 V' of the battery actually gives the maximum energy 1.2 kW h which can be stored. Many failed to get the correct answer as they wrongly multiplied this energy by the time of charging or made mistakes in the charging efficiency.

P = VI ~~1000 × 1.65 × 18.2% × time~~

P = 12 × 100

P = 1200 J h⁻¹

1000 × 1.65 × 18.2% × 80% × time = 1200 ✓

time = 5 hours ✓ day.

Assumpt that the charging process is with sunny ✓

答案，將不予評閱。

P = VI

P = 12 (100)

= 1200 W

1200/300 × 0.8 = 3.2小時 ✗

假設充电期間是阳光普照無云 ✓

太阳能板。

Capacity of battery = 100 × 3600 × 12

= 4320000 J

let the time required be t,

by E = Pt,

4320000 = 300t ✓

t = 4hrs ✗

Assumption : The solar panel delivers 300W ~~during~~ when charging ✗

Paper 2

Section B: Atomic World

HKDSE 2019

Multiple Choice

Qn.	1	2	3	4	5	6	7	8
A	13.5%	9.3%	64.9%	1.9%	51.8%	14.9%	11.6%	70.0%
B	21.3%	35.3%	17.8%	55.5%	10.5%	3.3%	37.9%	5.8%
C	22.8%	29.6%	13.2%	7.7%	7.7%	27.6%	22.5%	8.6%
D	42.4%	25.4%	3.6%	34.7%	29.7%	53.7%	27.5%	15.3%

KEY: underlined

Qn. 2.1

2.1 There are dark lines in the Sun's spectrum becauselights at certain wavelengths emitted by the Sun are

A. completely absorbed by the Sun's atmosphere.
B. completely absorbed by the Earth's atmosphere.
C. partly absorbed by the Sun's atmosphere.
D. partly absorbed by the Earth's atmosphere.

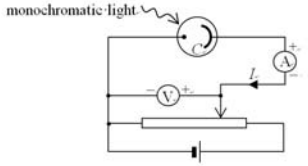
A B C D

favourable distractor

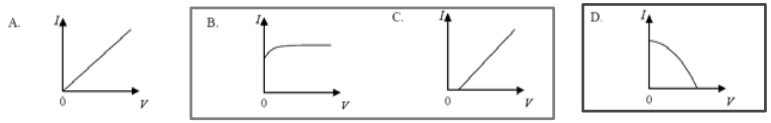
Answer : C (22.8%)
Best distracter: D (42.2%)
Most candidates think that the absorption spectrum is caused by the Earth's atmosphere. Not many candidates know that the Sun also has an atmosphere and the spectrum provides information about the atmosphere of the Sun.

Qn. 2.2

2.2 The set-up below is for investigatingthe maximum kinetic energy of photoelectrons in photoelectric effect.



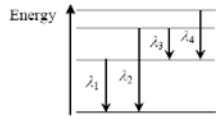
Monochromatic light of fixed intensity is shone on the cathode *C* of a photocell. The p.d. *V*applied across t photocell is adjusted and the corresponding current *I* is measured. What will be the graph of *I* against *V* ?



Answer : D (25.4%) favourable distractors
Best distracter: B (35.3%), C (29.6%)
Not many candidates realise that *V* is a retarding voltage. Therefore the graph is the negative part of the graph in the textbook, not the positive part (so they choose B). Some even mix the graph of stopping potential v.s. frequency with this (so they choose C).

Qn. 2.5

2.5 The energy diagram for an atom is shown below.



The electron transitions shown give rise to emission lines of wavelengths λ_1, λ_2, λ_3 and λ_4 respectively. Which of the following is/are correct ?

(1) $\frac{1}{\lambda_3} < \frac{1}{\lambda_4}$
(2) $\lambda_1 < \lambda_2$
(3) $\lambda_1 + \lambda_3 = \lambda_2$

A. (1) only
B. (2) only
C. (1) and (2) only
D. (2) and (3) only

favourable distractor

Answer : A (51.8%)
Best distracter: D (29.7%)
It seems that some candidates mistakenly mix up frequency and wavelength. The effect of energy change is reversed. The best distracter is the negation of the answer.

Qn. 2.7

2.7 Two point sources of red light at a distance of 160 m from an observercan just be resolved by the naked eyes. If they are replaced by point sources ofviolet light, how should the observer move from the original position such that the two sources can just be resolved?

A.	move about 280 m further away from the sources
B.	move about 120 m further away from the sources
C.	move about 120 m towards the sources
D.	move about 70 m towards the sources

favourable distractors

Answer : B (37.9%)

Best distracters: C (22.5%), D (27.5%)

This problem uses the Rayleigh criterion. Some candidates cannot catch this idea and got stuck with the thinking that the second situation (violet light) should have a lower resolution so that the observer should move towards the source. Therefore half of the candidates choose C and D.

Q.2 Structural question

(a) In Thomson's 'plum-pudding' model of atoms,an atom consists of a lump of positive material embedded with negatively-charged electrons distributed throughout.

(i) In order to test this atomic model, an experiment was performed such that a beam of α particles was shot at a gold foil and the deflections of the α particles were measured.State the result(s) of this scattering experiment. (2 marks)

(ii) Thomson's atomicmodelcannot account for the resultsof the scatteringexperiment in (a)(i).Why ? (1 mark)

(a) (i) Most alpha particles passed (straight) through the foil. 1A
some were only slightly deflected.

Asmall number of alpha particles were scattered at large 1A
angles and a few even rebounded backward.

It seemed that most candidates knew the results of Rutherford's scattering experiment, however, some failed to provide a concise description regarding the degree of deflection and the amount of alpha particles being deflected.

Q.2 Structural question

(ii) Since the charge and mass of an atom in Thomson's atomic model are evenly distributed, the alpha particles should not be deflected (by large angles). 1A

Poorly answered. More than half of the candidates held the belief that the majority of the alpha particles would be rebounded backward if the Thomson's atomic model were true.

Q.2 Structural question

(b) The diagram below represents some energy levels of a hydrogen atom.The ground state energy E_0 of hydrogen atom is −13.6 eV.

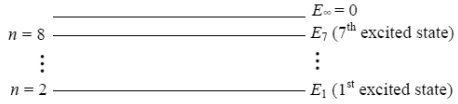


Figure 2.1

Diagram **NOT** drawn to scale

Q.2 Structural Question

(i) All energy levels of a hydrogen atom take negative valuesexcept E_∞. State the physical significance of energy levels having 'negative values' and the implication of an electron being at E_∞. (2 marks)

(b) (i) The electron is bounded by the nucleus, i.e. energy/work must be supplied in order to remove the electron from the atom/ionize the atom. 1A

An electron at E_∞ is not bounded by the attractive force from the nucleus, i.e. free. 1A

Weaker candidates did not know the physical significance according to the energy change. Some tried to relate it with the force of attraction between electrons and the nucleus. Some said that E is negative as E is lower than E_∞ , which is 0.
Most candidates can give the meaning of an electron being at E_∞ .

Q.2 Structural Question

(ii) What is the wavelength of electromagnetic wave emitted from a hydrogen atom which undergoes a transition from its7th excited state ($n = 8$) to the 1st excited state($n = 2$). (3 marks)

(ii) $\Delta E = E_7 - E_1$

$= -13.6\left(\frac{1}{8^2} - \frac{1}{2^2}\right)$ 1M

$= 3.1875\text{eV} \approx 3.1875 \times (1.60 \times 10^{-19})\ \text{J}$

$\lambda = \frac{hc}{\Delta E} = \frac{(6.63\times10^{-34})(3\times10^{8})}{3.1875 \times (1.60 \times 10^{-19})}$ 1M

$= 3.9 \times 10^{-7}\ \text{m} \approx 390\text{nm}$ 1A

Candidates' performance in (b)(ii) was satisfactory. Most knew how to find the energy difference ΔE corresponding to the electron transition though a few failed to obtain the correct wavelength λ. Some candidates had difficulties of +/- sign and the correct use of e=1.6 × 10^{-19} C.

Q.2 Structural Question

(iii) Find the minimum energy required to ionize a hydrogen atom from its3rd excited state (not shown). (2 marks)

(iii) $E_3 = -\frac{13.6}{4^2} = -0.85\text{eV}$ 1M

Energy required = 0 – (–0.85)
= 0.85eV or 1.36×10^{-19}J 1A

Some candidates just took the energy of the 3rd excited state instead of the difference between this value and E_∞ as the energy for ionizing an atom at that particular energy level (they quoted 'Energy required = E_3 = 0.85 eV' and get a correct numeric answer). Some candidates mistakenly used n = 3 for the 3rd excited state.

The End

HKDSE 2019
Physics Paper 2
Section D: Medical Physics

Multiple Choice Questions

Qn	1	2	3	4	5	6	7	8
A	6%	7%	**40%**	22%	**60%**	11%	10%	13%
B	29%	**43%**	24%	7%	13%	14%	13%	**63%**
C	**20%**	25%	26%	15%	15%	**54%**	15%	15%
D	45%	25%	10%	**56%**	12%	21%	**62%**	9%

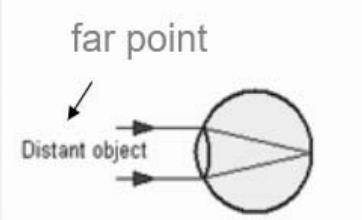
Qn. 4.1

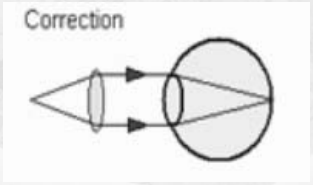
1. John suffers from long-sightedness. After wearing suitable corrective spectacles, how would his near-point distance and far-point distance be affected ?

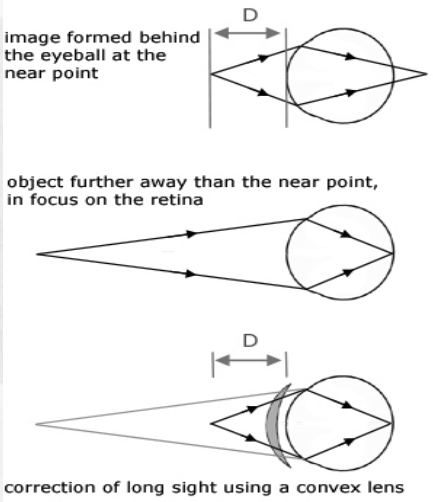
		near-point distance	far-point distance
A	6%	increased	increased
B	29%	increased	unchanged
C*	**20%**	decreased	decreased
D	45%	decreased	unchanged

favourable distractor

Qn 4.1 Answer







Qn. 4.2

2. An object is placed 20 cm in front of a concave lens. The magnification of the image is 0.5. Find the power of the lens?

		Power of lens
A	7%	+20 D
B*	43%	–5 D
C	25%	–10 D
D	25%	–20 D

favourable distractors

5

Qn. 4.2 Answer

- A dioptre is a unit of measurement of the optical power of a lens or curved mirror, which is equal to the reciprocal of the focal length measured in metres (1 dioptre = 1 m^{-1}). It is thus a unit of reciprocal length.

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\frac{1}{f} = \frac{1}{-10\ cm} + \frac{1}{20\ cm}$$

$$\frac{1}{f} = \frac{-2+1}{20\ cm} = \frac{-1}{20\ cm} = \frac{-1}{0.2\ m} = -5D$$

6

Qn. 4.3

3. The maximum sensitivity of human ear to sound of frequency 3 kHz is about 0.5 dB, which is the minimum change in sound intensity level that can be detected by the ear. This corresponds to a change of sound intensity of approximately

		Change in sound Intensity
A*	40%	12%.
B	24%	6%.
C	26%	3%.
D	10%	1%.

favourable distractor

7

Qn. 4.3 Answer

$$L_i = 10log\frac{I_1}{I_0}\ dB$$

$$0.5\ dB = 10log\frac{I_1}{I_0}\ dB$$

$$I_1 = 10^{0.05}\ I_o = 1.122\ I_o$$

$$\frac{I_1 - I_0}{I_o} = 0.122 = 12\%$$

where:
L_I – sound intensity level,
I – sound intensity [W/m^2],
I_0 – reference sound intensity 10^{-12} [W/m^2].

8

Qn. 4.4

4. Which of the following is/are non-invasive medical imaging method(s) ?
   (1) endoscopy
   (2) computed tomography (CT) scan
   (3) radioactive tracers

		Non-invasive methods
A	22%	(1) only
B	7%	(3) only
C	15%	(1) and (2) only
D*	56%	(2) and (3) only

favourable distractor

9

Qn. 4.6

6. Which statement about a 'hot spot' and a 'cold spot' in a radionuclide image is correct ?

		Correct statement
A	11%	A cold spot indicates the degree of abnormality of a particular organ but a hot spot does not.
B	14%	Both indicate the concentration of artificial contrast medium in a particular organ.
C*	54%	Both indicate the concentration of the radioactive tracer in a particular organ.
D	21%	Both indicate the degree of reflection of the radiation by the abnormal part of an organ.

favourable distractor

10

Qn. 4.6 Answer

The areas where the **radionuclide** collects in greater amounts are called '**hot spots**.' The areas that do not absorb the **radionuclide** and appear less bright on the scan **image** are referred to as '**cold spots**.'

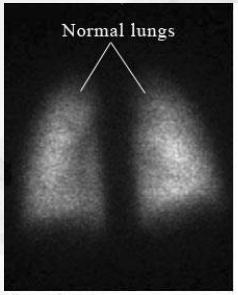


Figure 1

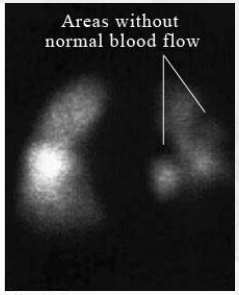
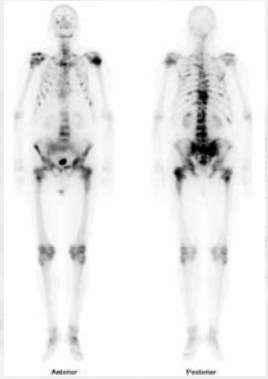


Figure 2


Case 2: metastases

11

Q.4 (a) Structural question

(a) An endoscope is made of a bundle of optical fibres with each optical fibre having a glass core surrounded with a cladding as shown in Figure 4.1. The endoscope can be inserted through natural openings of a patient in order to view internal organs. The refractive index of the glass core and that of the surrounding cladding are 1.5 and 1.45 respectively.

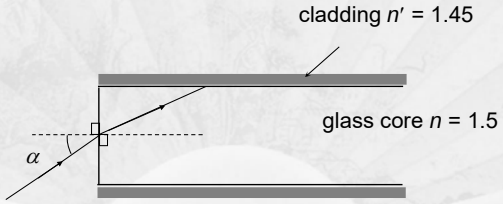


Figure 4.1

12

Q.4 (a) Structural question

(i) Find the critical angle *c* for the core-cladding boundary. (1 mark)

(ii) Explain why a light ray entering the glass core at an angle α as shown can be guided through the core without leakage only if α is less than a certain angle α_{max}. (2 marks)

(iii) A patient suffers from stomach ulcer (i.e. a wound on the stomach lining). State **ONE** advantage and **ONE** disadvantage of examining the stomach using endoscopy over radiographic imaging using X-rays. (2 marks)

Q.4 (b) Structural question

(b) The table shows information relating to the transmission of sound through different types of body tissues.

Tissue	Speed of sound / m s^{-1}	Acoustic impedance / kg m^{-2} s^{-1}
Bone	3780	7.15×10^6
Muscle	1590	1.65×10^6
Fat	1450	1.37×10^6

(i) Estimate the density of bone. (1 mark)

(ii) When ultrasound is incident to a 'muscle-bone' boundary, find the ratio of the intensity of ultrasound reflected from the boundary to that incident to the boundary. (2 marks)

(iii) Explain why in an ultrasound scan a 'muscle-bone' boundary is easier to be distinguished compared to a 'muscle-fat' boundary. (2 marks)

Q.4 (a) Marking Scheme

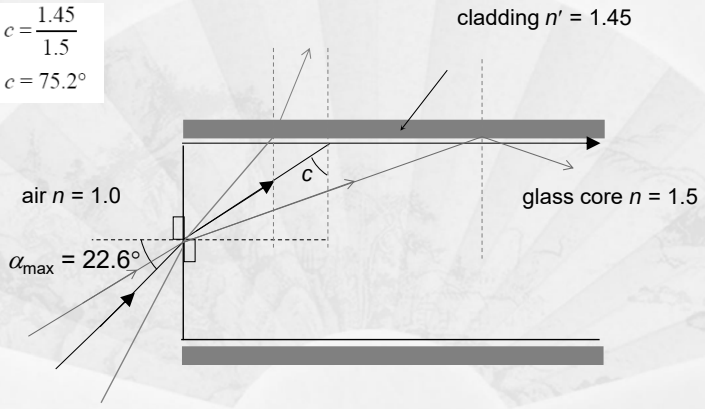
	Solution	Marks
(a) (i)	$\sin c = \frac{1.45}{1.5}$ $c = 75.2°$	1A
(a) (ii)	For α *larger than* α_{max}, subsequently the light ray incident angle at the core-cladding boundary would be less than *c*, thus **total internal reflection** fails to occur. Note: *There are two boundaries involved: air-core and core-cladding. Candidates need to state explicitly which boundary that total internal reflection occurs*	1A 1A
OR	For α *less than* α_{max}, subsequently the light ray incident angle at the core-cladding boundary would be greater than *c*, thus **total internal reflection** occurs.	1A 1A
OR	Correct description, but without mentioning core-cladding boundary	1A

Optical fibres

$1.5 \times \sin c = 1.45 \times \sin 90°$

$\sin c = \frac{1.45}{1.5}$

$c = 75.2°$



Q.4 (a) Marking Scheme

	Solution	Marks
(a) (iii)	When comparing to X-rays radiographic imaging:	
	Advantage: Any **ONE** - direct view of the stomach lining / inside / wall (situation/condition/function of inner structure of stomach) - perform biopsy (getting a tissue) /surgery during examination if necessary - without exposure to **ionizing** radiation by X-rays	1A
AND	Disadvantage: Any **ONE** - requires fasting (for a few hours) prior to examination. - endoscopy is an invasive procedure / having a risk of causing patient internal bleeding /discomfort / unwell - anesthetic may be needed - X-rays imaging is non-invasive	1A

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Q.4 (b) Marking Scheme

	Solution	Marks
(b) (i)	$Z_B = \rho c$ $7.15 \times 10^6 = \rho\,(3780)$ $\rho = 1890\ \text{kg m}^{-3} \sim 1900\ \text{kg m}^{-3}$	1M/1A
(b) (ii)	$\alpha_b = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2} = \frac{(7.15-1.65)^2}{(7.15+1.65)^2}$ $\alpha_b = \frac{I}{I_0} = 0.390625 \approx 0.391 = 39.1\%$ $\quad \alpha_b = 0.39 \sim 0.391$	1M 1A
OR	$\alpha_b = \left(\frac{5.5}{8.8}\right)^2 = \frac{25}{64}$	1A

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Q.4 (b) Marking Scheme

	Solution	Marks
(b) (iii)	- The <u>difference in acoustic impedances</u> of a muscle-bone boundary is greater than that of a muscle-fat boundary (<u>or</u> *vice versa*), - therefore giving a <u>larger intensity reflection coefficient</u> α_b (~39%) / <u>larger intensity reflection ratio</u> (<u>or</u> *vice versa*), *so more clear / easier to be distinguished.* *Note: coefficient, ratio, percentage, proportion*	1A 1A
OR	$\alpha_{(muscle\text{-}fat)} = 0.00859 = 0.86\%$ as a supporting statement that $\alpha_{(muscle\text{-}fat)}$ is less than $\alpha_{(muscle\text{-}bone)}$	1A

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4a(ii) Sample answers

1. If α is less than a certain max angle, light ray in the glass core can be guided through the core without leakage.
2. 'internal reflection', 'total reflection'.
3. Total internal reflection occurs if α is less than α_{max} .
4. It is because an angle larger than α_{max} will lead to angle of incidence of core-cladding boundary larger than the critical angle of boundary. The light ray is leaked out of the endoscope and cannot be guided.
5. $\alpha < \alpha_{max}$, then angle of incidence at core cladding boundary will be less than critical angle, so total internal reflection occurs so, light will not leak out.

20

4a(ii) Sample answers

6. When α increases, corresponding angle at core-cladding boundary will decrease, when smaller than critical angle, no total internal reflection.
7. 因為 α 小於臨界角 α_{max}才能進行全內反射。
8. α 必需少於 α_{max} , 因為 α_{max} 是使玻璃纖芯射向包覆層時入射角為 75.2°，剛好為臨界角。而 α 少於 α_{max}時，空氣玻璃纖芯界面的折射角便小於 14.8°，c 便大於 75.2°，導致全內反射發生，不會漏光。

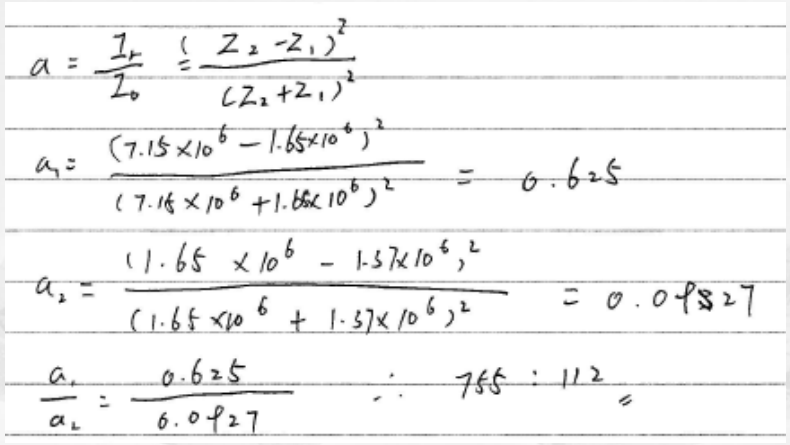
4a(iii) Sample answers

1. Endoscopy is more expensive than using X ray.
2. 有較大機會對傷口造成感染。
3. Endoscopy can view the function of the inner structure.
4. Endoscopy has no "ionizing power“ .
5. Endoscopy is non-ionization / non-radioactive.
6. Advantage is endoscopy wouldn’t cause cancer, but X-ray can cause cancer as it ionizes cells.
7. Disadvantage: It can see the overview of the outside structure/surface of the stomach.

4a(iii) Sample answers

8. Endoscopy can give 3D image but X-rays can only give 2D image.
9. The patient may feel inconvenient as the endoscopy need to go inside into the body.
10. Advantage : ‘could prevent harm by radiation’.
11. Endoscopy has a narrow field of view.
12. Disadvantages :容易觸碰胃黏膜的損傷位置 / 碰到傷口的損傷位置。

4b(ii) Sample answers



4b(ii) Sample answers

$\alpha = \frac{(1590-3780)^2}{(1590+3780)^2}$

$\alpha = 0.166318$

$\alpha = \frac{(7.15\times10^6 - 1.65\times10^6)^2}{(7.15\times10^6 + 1.65\times10^6)^2}$

$= \frac{25}{64}$

$\frac{\text{反射超声波}}{\text{入射超声波}} = \frac{\frac{25}{64}}{1-\frac{25}{64}}$

$= \frac{25}{39}$

反射超声波：入射超声波 = 25 : 39

4b(iii) Sample answers

1. Amplitude of reflected ultrasound is larger.
2. Difference in acoustic impedance is larger, ... so the reflective index will be higher.
3. As bone has a higher acoustic impedance than that of fat, ... muscle-bone boundary reflection...
4. It is because the difference of Z between muscle and bone is larger than the difference of Z between muscle and fat. The ratio of reflecting ultrasound to incident ultrasound is larger in muscle-bone boundary.
5. Higher intensity of ultrasound is reflected from muscle-bone.

4b(iii) Sample answers

6. Because muscle and fat has similar acoustic impedance... $\alpha_{(muscle\text{-}fat)} = 0.00859 = 0.86\%$, which is much smaller that of $\alpha_{(muscle\text{-}bone)}$ boundary. Hence muscle-bone boundary is more easier to be detected.
7. 因為肌肉和脂肪同屬軟組織容易吸收聲波，超聲波掃描後，圖像的形態相近。但骨較容易反射超聲波，掃描後的圖形上，肌肉是較少反射物，而骨是較多的，因而產生強烈的差別 ， 較易區別。
8. 因骨明顯較為硬，其聲音速度為 3780 m s^{-1} ，明顯與肌肉的 1590 m s^{-1} 及脂肪的 1450 m s^{-1} 相距夠大會容易分別。

The End

Qn. 4.5

5. Which statement about radiographic imaging and computed tomography (CT) scan is correct ?

		Correct statement
A*	60%	Both make use of the different degree of attenuation of the radiation beam through various body tissues.
B	13%	The X-rays used in radiographic imaging are ionizing radiations while CT scans employ non-ionizing radiations.
C	15%	CT scans produce images of relatively higher resolution because gamma radiation is used.
D	12%	CT scans cannot be used for organs with cavity.

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Qn. 4.7

7. The effective half-life of a certain radioactive tracer *X* is 6.9 hours. If the biological half-life of *X* is 2 days, find its physical half-life.

		Half-life
A	10%	2.8 hours
B	13%	6.0 hours
C	15%	7.3 hours
D*	62%	8.1 hours

30

Qn. 4.8

8. A gamma source *Y* is used externally for treatment of cancer. At a certain point from source *Y* the equivalent dose rate is 24 μSv per hour. It is found that 242 mm of concrete shielding is needed to reduce the equivalent dose rate to 1.5 μSv per hour at the same point. The half-value thickness of concrete for gamma radiation is

		Half-value thickness
A	13%	48.4 mm.
B*	63%	60.5 mm.
C	15%	80.6 mm.
D	9%	121.0 mm.

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