Belilios Public School

2022-2023

MOCK EXAMINATION

S6 PHYSICS PAPER 2

Question-Answer Book

Time allowed: 1 hour

This paper must be answered in English.

Name	
Class	
Class number	

(1) Write your Name, Class and Class number in the spaces provided on this cover.

(2) This paper consists of **TWO** sections, Sections C and D. Each section contains eight multiple-choice questions and one structured question which carries 10 marks. Attempt **ALL** questions in all **TWO** sections.

(3) Write your answers to the structured questions in the **ANSWER BOOK** provided. For multiple-choice questions, blacken the appropriate circle with an HB pencil. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

(5) Graph papers and supplementary answer sheets will be provided on request. Write your name, class and class number on each sheet, and fasten them with a string inside the Answer Book.

(6) The Question-Answer Book and the Answer Book will be collected **SEPARATELY** at the end of the examination.

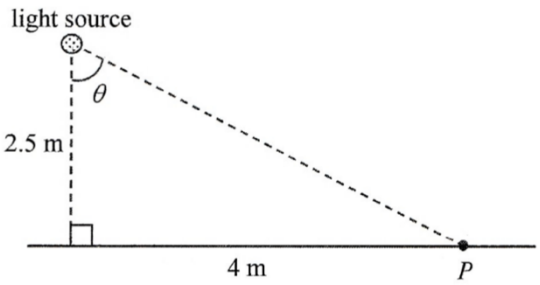
(7) The diagrams in this paper are **NOT** necessarily drawn to scale.

(8) The last two pages of this Question-Answer Book contain a list of data, formulae and relationships which you may find useful.

Section C: Energy and Use of Energy

Q.3 Multiple-choice questions

3.1



A point light source gives out a steady luminous flux of 2400 lm in all directions. Calculate the illuminance at the point *P* on the surface as shown in the above figure.

A. 4.55 lux
B. 6.33 lux
C. 7.28 lux
D. 16.2 lux

A B C D

○ ○ ○ ○

3.2 Which of the following statements concerning induction cooker and microwave oven is correct?

A. The end-use efficiency of an induction cooker is generally higher.
B. Both cookers make use of the heating effect of current to generate heat.
C. Both cookers generate heat directly in the food.
D. Both cookers have no limitation on the type of cookware used.

A B C D

○ ○ ○ ○

3.3 A wind turbine has 3 blades, each of length 18 m. When steady wind blows normally on the blades of the turbine, the turbine rotates to drive the generator to give out an electrical power of 350 kW. If the efficiency of the turbine is 28%, find the average velocity of the wind. Given the density of air is 1.2 kg m^{-3}.

A. 8.8 m s^{-1}
B. 12.7 m s^{-1}
C. 16.0 m s^{-1}
D. 18.4 m s^{-1}

A B C D

○ ○ ○ ○

3.4 A hybrid car consumes much less petrol than a petrol car of similar model and power for travelling the same distance. Which of the following are the reasons?

(1) The battery can be recharged when the car is not in used.
(2) The excess power of the engine is used to recharge the batteries.
(3) The regenerative brake can recycle some kinetic energy of the car to recharge the battery.

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

A B C D

3.5 The solar constant is 1370 W m^{-2}. The atmosphere absorbs an average of 38.5% of solar power. If a solar panel is designed to give a maximum electrical power output of 2.5 kW, what should be the minimum surface area of the panel? Assume the efficiency of the solar panel is 15%.

A. 10 m^2
B. 15 m^2
C. 20 m^2
D. 30 m^2

A B C D

3.6 Glass with low-emissivity coating can reduce heat transfer into a building by

A. reflecting mainly ultra-violet radiation.
B. reflecting mainly infra-red radiation.
C. absorbing mainly ultra-violet radiation.
D. absorbing mainly infra-red radiation.

A B C D

3.7 The Three Gorges Dam is the world's largest hydroelectric power station. The difference in water level on two sides of the dam is about 180 m. In the year 2008, 26 turbine generator units had been installed to provide a total of 18200 MW of electricity generating capacity. Estimate the flow rate of water through each turbine near the lower reservoir when the power station operates at its full capacity. Assume the overall efficiency of the generators is 85%.

A. 4.75×10^4 kg s^{-1}
B. 4.66×10^5 kg s^{-1}
C. 4.58×10^6 kg s^{-1}
D. 1.21×10^7 kg s^{-1}

A B C D

3.8 In nuclear reactor, a U-235 nucleus undergoes fission by a neutron and breaks into two daughter nuclei *X* and *Y*. Which of the following statements are correct?

(1) The mass number of U-235 equals the sum of the mass numbers of *X* and *Y*.
(2) The fusion of *X* and *Y* needs to absorb energy.
(3) The binding energy per nucleon of *X* is greater than that of U-235.

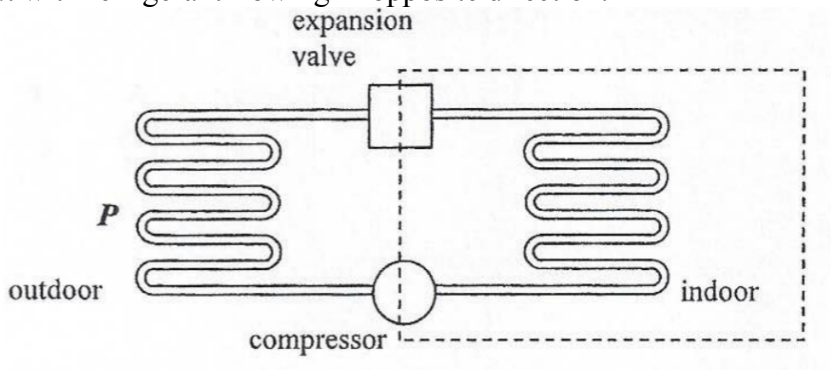
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

A B C D

Q.3 Structured question

In recent years, RCAC (reverse cycle air conditioning) is promoted to replace the electric heater (using heating effect of current). Figure 3.1 shows the system used in RCAC, which is similar to that of a refrigerator but with refrigerant flowing in opposite direction.

Figure 3.1



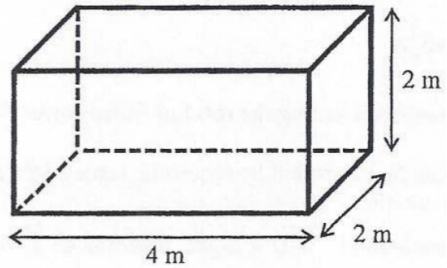
(a) (i) In which direction does the refrigerant flow through the compressor in RCAC (from indoor to outdoor OR from outdoor to indoor)? (1 mark)

(ii) Describe the change of state of the refrigerat and the heat exchange when it flows through component *P*. (2 marks)

(iii) Why is the component *P* coil up? Explain briefly. (1 mark)

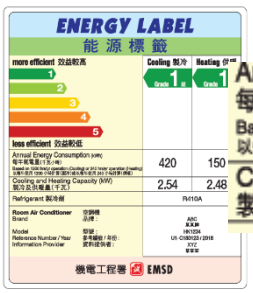
(b) Figure 3.2 shows the dimensions of a compartment. The compartment is insulated using 0.02 m thick polystyrene. The thermal conductivity of polystyrene is 0.03 W m^{-1} K^{-1}.

Figure 3.2



An RCAC air conditioner with the energy label shown in Figure 3.3 is installed in the compartment. The heating capacity is the rate of heat pumped into indoor.

Figure 3.3



	Cooling	Heating
Annual Energy Consumption (kWh) 每年耗電量(千瓦小時) Based on 1200 hrs/yr operation (Cooling) or 240 hrs/yr operation (Heating) 以每年使用 1200 小時計算(製冷)或以每年使用 240 小時計算(供暖)	420	150
Cooling and Heating Capacity (kW) 製冷及供暖量(千瓦)	2.54	2.48

A tempe ·0 °C is maintained between the exterior and the interior surfaces.

(i) Calculate the rate of heat coducted away from the apartment. Hence, determine whether the air conditioner has enough heating capacity. (3 marks)

(ii) How much electrical energy is consumed by the air conditioner when it gives 2480 J of heat energy to indoor? (1 mark)

(iii) Hence, explain why RCAC is more energy saving than electric heater. (1 mark)

(iv) Some electrical energy is used to operate a fan inside the air conditioner. Explain. (1 mark)

Section D: Medical Physics

Q.4 Multiple-choice questions

4.1 Roger is suffering from an eye defect and he has to wear the spectacles with power –2.5 D. State the eye defect Roger suffered from and find his **near point** with the spectacles.

	eye defect	near point
A	long sightedness	25 cm
B.	long sightedness	66.7 cm
C.	short sightedness	25 cm
D.	short sightedness	66.7 cm

A ○ B ○ C ○ D ○

4.2 Two point objects of separation 1mm emitting green light of wavelength 550 nm are observed by Jacky such that he can just resolve them. If the objects are now emittinng red light of wavelength 700 nm instead, estimate the distance Jacky needs to walk towards the object such that he can just resolve them. (Assume that the diamter of the pupils of his eyes is about 3 mm in normal daylight.)

A. 0.96 m
B. 3.51 m
C. 4.47 m
D. 16.4 m

A ○ B ○ C ○ D ○

4.3 The sound intensity detected inside the room with all windows opened is 4.0×10^{-5} W m^{-2}. The windows are designed to reduce the sound intensity level by 45 dB. What is the sound inte弓sity in the room after closing the windows?

A. 1.3×10^{-9} W m^{-2}
B. 2.6×10^{-9} W m^{-2}
C. 1.6×10^{-8} W m^{-2}
D. 3.2×10^{-8} W m^{-2}

A ○ B ○ C ○ D ○

4.4 The following table shows the speed of sound in muscle and bone and their corresponding densities.

Tissue	Speed of sound in tissue / m s^{-1}	Density / kg m^{-3}
Muscle	1580	1076
Bone	3050	2560

Calculate the percentage of intensity trasmitted through a muscle-bone boundary.

A. 9.1%
B. 41.3%
C. 58.7%
D. 90.9%

4.5 Which of the following concerning the ultrasound scan is NOT correct?

A. Diffraction of ultrasound affects the resolution of B-scan image.
B Higher frequency of ultrasound attenuates quicker in body tissues.
C. The image represents the attenuation of ultrasound in body tissues.
D. Coupling gel is applied to reduce the reflection of ultrasound by skin.

A B C D

4.6 Which of the following statements about endoscope is/are correct?
(1) Coherent bundles is used to transmit image for observation.
(2) Only coherent bundles transmit light by total internal reflection.
(3) Resolution of the image depends on the coherent bundles, but not the incoherent bundle.

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

A B C D

4.7 Which of the following about radionuclide imaging (RNI) is INCORRECT?

A. Only pure *gamma* source is used as tracer.
B. A hot spot confirms that a tumour exists.
C. RNI can provide the functional information about the organ.
D. The image resolution of RNI is poorer than that of an X-ray image.

A B C D

4.8 A radioactive isotope has a physical half-life of 12 hours and a biological half-life of x hours. If 8 mg is injected into the body of a patient, which of the following about the effective half-life of the isotope and the remaining amount of isotope after 12 hours is correct?

	Effective half-life	Remaining Amount
A.	> 12 hours	> 4.0 mg
B.	> 12 hours	= 4.0 mg
C.	< 12 hours	= 4.0 mg
D.	< 12 hours	< 4.0 mg

A B C D

Q.4 Structured question

(a) State briefly how X-rays are produced. (1 mark)

(b) The table below shows the linear attenuation coefficients of soft tissue and bone for an X-ray beam.

	linear attenuation coefficient
soft tisse	$\mu_s = 0.51\,\text{cm}^{-1}$
bone	$\mu_b = 2.46\,\text{cm}^{-1}$

(i) Calculate the half-value thickness of soft tissue. (1 mark)

(ii) Briefly explain the difference in linear attenuation coefficent between bone and soft tissue. (1 mark)

(ii) X-ray beam of intensity I_0 passes through the upper arm of thickness 10 cm which consists of soft-tissues and bone only and is attenuated to intensity $1.23\times10^{-4}I_0$. Estimate the thickness of the bone. (2 marks)

(c) Images below are an X-ray radiographic image and a Computed Tomography (CT) coronal reformatting image of a patient's chest.

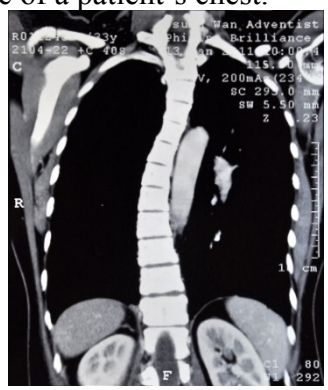


Image *A*

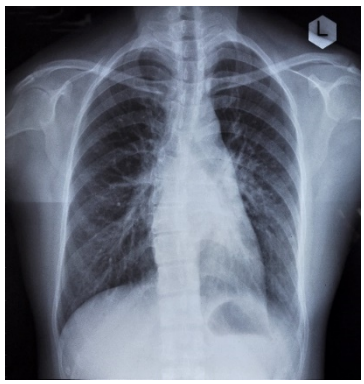


Image *B*

Briefly describe how the above images are produced. (3 marks)

(d) A patient is suspected to have a liver disease. Before using radionuclide imaging, the doctor suggest the patient to have an ultrasound exmaination.

(i) Explain why X-ray radiographic imaging is not suitable for examination in this case. (1 mark)

(ii) Computed tomography (CT) can also give accurate diagnosis. Other than being expensive, state a reason why the doctor does not suggest the patient to have a CT scanning. (1 mark)

END OF PAPER

List of data, formulae and relationships

Data

molar gas constant	$R = 8.31\ \text{J mol}^{-1}\ \text{K}^{-1}$
Avogadro constant	$N_A = 6.02 \times 10^{23}\ \text{mol}^{-1}$
acceleration due to gravity	$g = 9.81\ \text{m s}^{-2}$ (close to the Earth)
universal gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$
speed of light in vacuum	$c = 3.00 \times 10^8\ \text{m s}^{-1}$
charge of electron	$e = 1.60 \times 10^{-19}\ \text{C}$
electron rest mass	$m_e = 9.11 \times 10^{-31}\ \text{kg}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2\ \text{N}^{-1}\ \text{m}^{-2}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\ \text{H m}^{-1}$
atomic mass unit	$u = 1.661 \times 10^{-27}\ \text{kg}$ (1 u is equivalent to 931 MeV)
astronomical unit	$\text{AU} = 1.50 \times 10^{11}\ \text{m}$
light year	$\text{ly} = 9.46 \times 10^{15}\ \text{m}$
parsec	$\text{pc} = 3.09 \times 10^{16}\ \text{m} = 3.26\ \text{ly} = 206265\ \text{AU}$
Stefan constant	$\sigma = 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$

Rectilinear motion

For uniformly accelerated motion :

$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

Mathematics

Equation of a straight line	$y = mx + c$
Arc length	$= r\theta$
Surface area of cylinder	$= 2\pi rh + 2\pi r^2$
Volume of cylinder	$= \pi r^2 h$
Surface area of sphere	$= 4\pi r^2$
Volume of sphere	$= \frac{4}{3}\pi r^3$

For small angles, $\sin\theta \approx \tan\theta \approx \theta$ (in radians)

Astronomy and Space Science

$U = -\frac{GMm}{r}$	gravitational potential energy
$P = \sigma AT^4$	Stefan's law
$\left\|\frac{\Delta f}{f_0}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda_0}\right\|$	Doppler effect

Energy and Use of Energy

$E = \frac{\Phi}{A}$	illuminance
$\frac{Q}{t} = \kappa\frac{A(T_H - T_C)}{d}$	rate of energy transfer by conduction
$U = \frac{\kappa}{d}$	thermal transmittance U-value
$P = \frac{1}{2}\rho Av^3$	maximum power by wind turbine

A1.	$E = mc\,\Delta T$	energy transfer during heating and cooling
A2.	$E = l\,\Delta m$	energy transfer during change of state
A3.	$pV = nRT$	equation of state for an ideal gas
A4.	$pV = \frac{1}{3}Nm\overline{c^2}$	kinetic theory equation
A5.	$E_K = \frac{3RT}{2N_A}$	molecular kinetic energy
B1.	$F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$	force
D1.	$F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$	electric field strength due to a point charge
D3.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D4.	$R = \frac{\rho l}{A}$	resistance and resistivity
D5.	$R = R_1 + R_2$	resistors in series
D6.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D7.	$P = IV = I^2R$	power in a circuit