2014-15 MOCK
F.6 PHY
PAPER 2

TWGHs Wong Fut Nam College
Mock Examination 2014-15

F.6 PHYSICS PAPER 2

Question-Answer Book

11:30 am – 12:30pm (1 hour)
2 Feb 2015 (MON)

This paper must be answered in English

Setter: Leung Shu Kei

Student Name				
Class No.	6			

Question No.	Marks
Section A MC	
Section A Structured question	
Section C MC	
Section C Structured question	

INSTRUCTIONS

(1) After the announcement of the start of the examination, you should first write your name and class number in the space provided on the cover.

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

(3) Write your answers to the structured questions in this **QUESTION–ANSWER BOOK**. Do not write in the margins. Answer in the margins will not be marked. 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.

(4) Graph paper and supplementary answer sheets will be provided on request. Write your name and class number and mark the question number box on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.

(5) The diagrams in this section are **NOT** necessarily drawn to scale.

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

(7) No extra time will be given to candidates for filling in the question number boxes after the 'Time is up' announcement.

Section A: Astronomy and Space Science

Q.1: Multiple–choice questions

1.1 Aldebaran is the brightest star in the constellation of Taurus. It is at a distance of 20 pc from the Earth. Find the time required for the light to travel from Aldebaran to the Earth.

A. 4.5 years

B. 20.0 years

C. 34.8 years

D. 65.2 years

A B C D

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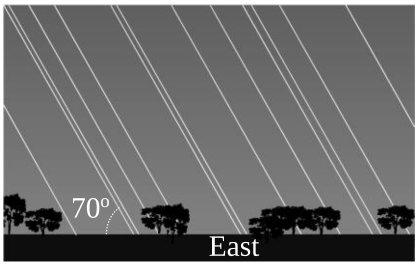
1.2 The following figure shows the star trails observed at the east horizon of a certain location throughout the night.



Which of the following statement(s) is / are correct?

(1) The stars observed at the east horizon are rising.

(2) The latitude of this location is 70° N.

(3) The Polaris can be observed at from this location at the North horizon.

A. (1) only

B. (2) only

C. (1) and (3) only

D. (2) and (3) only

A B C D

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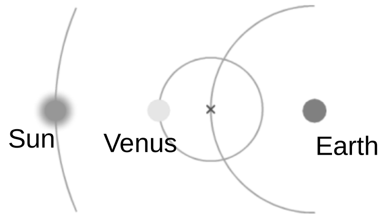
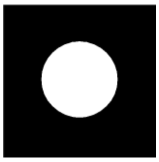
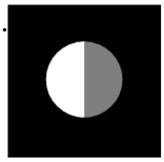
1.3 The figure below shows a possible orientation of Venus, the Sun and the Earth in a geocentric model.

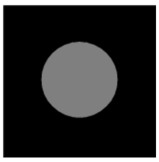


Which of the following best shows the phase of Venus as seen from the Earth at the instant shown?

A. 

B. 

C. 

D. 

A B C D

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1.4 Which of the following statement(s) correctly describe(s) the motion of a geostationary satellite??

(1) The satellite can move in an elliptical orbit.

(2) The orbital radius does not depend on the mass of the satellite.

(3) It has the same orbital angular speed as Earth.

A. (1) and (2) only

B. (2) and (3) only

C. (1) and (3) only

D. (1), (2) and (3)

A B C D

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1.5 The escape velocity of a spacecraft on the surface of the Earth is 1.10×10^4 m s^{-1}. What will be the escape velocity if the spacecraft is launched at a place which is 0.4 times the radius of the Earth above the ground?

A. 6.65×10^3 m s^{-1}

B. 7.86×10^3 m s^{-1}

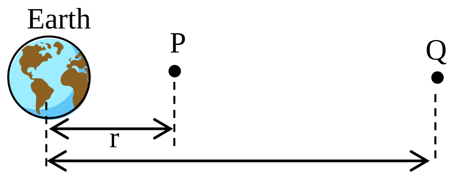
C. 9.30×10^3 m s^{-1}

D. 1.01×10^3 m s^{-1}

A B C D

○ ○ ○ ○

1.6 P and Q are two points at a distance r and 3r respectively from the centre of the Earth, as shown below. The gravitational potential (gravitational potential energy per unit mass) at P is – 12 kJ kg^{-1}. What is the work done in taking a 5 kg mass from point P to point Q?



A. 20 kJ

B. 40 kJ

C. 60 kJ

D. 80 kJ

A B C D

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1.7 The table below shows the apparent magnitudes and absolute magnitudes of three stars.

Star	**Apparent magnitude**	**Absolute magnitude**
Sirius *A*	–1.46	1.42
Vega	0	0.58
Polaris	1.97	–3.64

Which of the following statement(s) **MUST** be correct?

(1) As seen from the Earth, Sirius *A* is the brightest among the three stars.

(2) Among the three stars, Vega is the brightest.

(3) Among the three stars, Sirius *A* is the farthest away from the Earth.

A. (1) only

B. (3) only

C. (1) and (3) only

D. (2) and (3) only

A B C D

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1.8 Hubble's law states that the greater the distance of a galaxy from the Earth, the larger the receding velocity. Which of the following statement(s) about the law is / are correct?

(1) It is derived from the observation result using Doppler effect.

(2) It can explain by Newton's law of gravitation.

(3) It supports the Big bang model of the universe.

A. (1) and (2) only

B. (2) and (3) only

C. (1) and (3) only

D. (1), (2) and (3)

A B C D

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Q.1: Structured question

The Earth's orbital motion around the Sun results in a small change in the apparent direction of a relatively close star *X* when seen against the background of very distant stars.

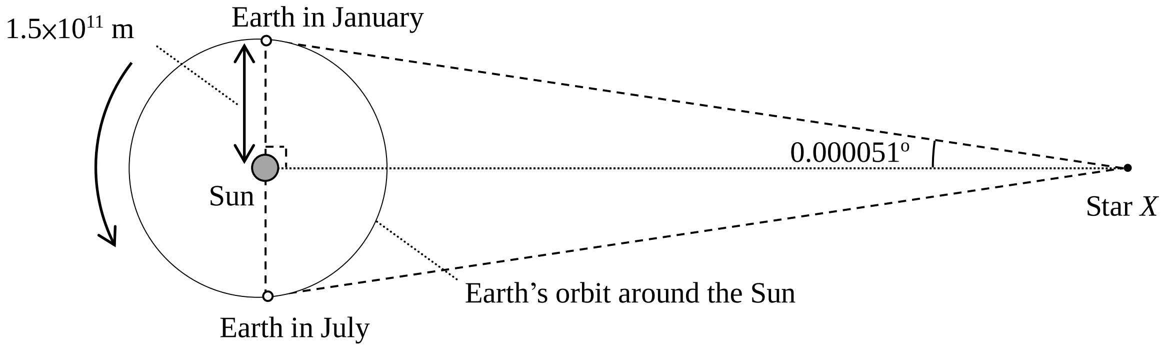

Figure 1.1

Assume the orbit of the Earth around the Sun is circular. As shown in Figure 1.1, the distance between the Earth and the Sun is 1.50×10^{11} m and the parallax of star *X* from January to July is 0.000051°.

(a) (i) Determine the distance between the star *X* and the Earth in January. (2 marks)

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(ii) Star Y has a similar luminosity as star *X*. However, Star *Y* seems to be dimmer than star *X* when observed from the earth. Compare the distances of star *X* and star *Y* from the Earth. (1 mark)

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(b) (i) Figure 1.2 shows how the radiation intensity from star *X* varies with wavelength. It is known that the surface temperature of star *Y* doubles the surface temperature of star *X*. Sketch on Figure 1.2 to show how the radiation intensity from star *Y* varies with wavelength (1 marks)

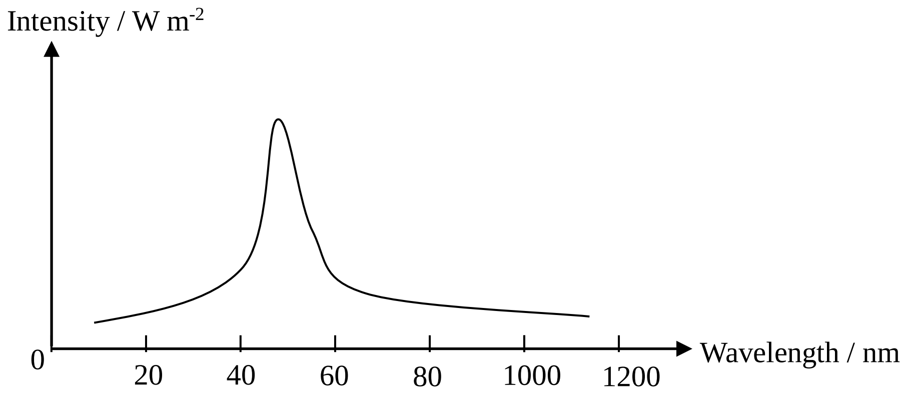

Figure 1.2

(iii) It is found that the radius of star *X* is about 3 R_{SUN}, where R_{SUN} is the radius of the sun. Estimate the radius of star *Y* in term of R_{SUN}. (2 marks)

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(c) An astronomer on the Earth analyses the spectrum of light from the star *Y*. A line of wavelength 490 nm in the spectrum produced on the Earth appears at a wavelength of 490.7 nm in a corresponding spectrum from the star Y.

(i) What is the name of the phenomenon observed by the astronomer? How does it tell you about the motion of the star *Y* relative to the Earth? (2 marks)

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(ii) Estimate the speed of the star relative to the Earth. (2 marks)

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Section C: Energy and Use of Energy

Q.3: Multiple–choice questions

3.1 Peter is suggested to replace a 60 W filament lamp by a 14 W compact fluorescent lamp which is known to have a luminous efficacy of 65 Lumen / W. Assuming that both lamps have the same luminous flux, which of the following statement(s) is/ are correct?

(1) The filament lamp has a higher end-use efficiency than the compact fluorescent lamp.

(2) Luminous flux of the filament lamp is 910 Lumen.

(3) Both lamps have the same brightness to the human eye when observed from the same distance

A. (1) and (2) only

B. (2) and (3) only

C. (1) and (3) only

D. (1), (2) and (3)

A ○ B ○ C ○ D ○

3.2 Which of the following statements about an electric hotplate, an induction cooker and a microwave oven is / are correct?

(1) Both an electric hotplate and an induction cooker make use of the heating effect of a cooker

(2) Metal cooking pots can be used for all these cookers.

(3) In general, an induction cooker has the highest energy efficiency while a microwave oven has the lowest.

A. (1) only

B. (2) only

C. (1) and (3) only

D. (2) and (3) only

A ○ B ○ C ○ D ○

3.3 Thermal conduction test are carried out for two rods of different U-value, length and cross-sectional area under different temperature difference across the two ends.

Rod	**U-value**	**length**	**Cross-sectional area**	**Temperature difference**
P	U	L	A	T
Q	1.2 U	0.6 L	0.7 A	1.1 T

Which of the following statements is / are correct?

(1) The rate of heat conduction in rod Q is faster in the tests.

(2) Rod P is made of material of greater thermal conductivity.

(3) Rod Q is a better heat insulation material.

A. (1) only

B. (2) only

C. (1) and (3) only

D. (2) and (3) only

A ○ B ○ C ○ D ○

3.4 Light is emitted evenly in all directions by a point light source with a luminous flux of 800 lm. Some is incident along the normal direction on a small surface, on which the illuminance is 100 lux. Find the distance, in metre, between the light source and the surface.

A. $\sqrt{2 / \pi}$
B. $1 / \pi$
C. $\sqrt{1 / 2 \pi}$
D. $1 / 2 \pi$

A B C D
○ ○ ○ ○

3.5 An air-conditioner consumes electrical power of 1.2 kW and removes heat at a rate of 3.0 kW. The cost of electricity is $ 1.1 / kWh. Which of the following statement(s) is / are correct?

(1) The cost of electricity in removing 21.6 MJ of heat by the air-conditioner is $2.64.
(2) The coefficient of performance of the air-conditioner is 2.5.
(3) The cooling capacity of the air-conditioner is 1.2 kW.

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

A B C D
○ ○ ○ ○

3.6 In a hydroelectric power plant, water flows from the upper level to the lower level at a rate of 3600 kg s^{-1} and drive the turbine. The difference between the water level is 120 m.
What is the efficiency of the turbine if the power output of the turbine is 2.59 MW?

A. 40 %
B. 50 %
C. 60 %
D. 70 %

A B C D
○ ○ ○ ○

3.7 In making use of wind turbines to generate electrical energy, which of the following is **NOT** a possible impact(s) on the environment and society?

A. Visual impact on the landscape.
B. Noise pollution is significant.
C. Hugh amount of space is required to build wind farm.
D. High running cost of the wind turbines

A B C D
○ ○ ○ ○

3.8 The main reason why a chain reaction can occur in a nuclear reactor using uranium is that

A. The products of nuclear fission of uranium are radioactive.
B. Neutrons are produced when a uranium nucleus undergoes fission.
C. A large quantity of energy is released in each fission reaction of uranium nucleus.
D. Uranium is highly radioactive element.

A B C D
○ ○ ○ ○

Q.3: Structured question

Figure 3.1 shows a solar-powered electric car which is driven by electric motor. This car has a battery set which gives a total e.m.f of 80 V. The battery set delivers a current to drive the electric motor.

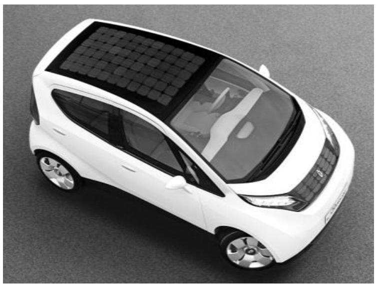

Figure 3.1

(a) When the car moves with a steady speed of 60 km h^{-1}, the power output of the car is 12 kW. The efficiency of the electric motor is 80%.

(i) Calculate the current delivered by the battery. (2 marks)

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(ii) If the total energy stored by the battery is 28 kWh, calculate the maximum distance that can be travelled by the electric car under this speed. (3 marks)

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(iii) A large amount of energy in the battery is consumed during the acceleration of the car. To prolong the travelling distance of the car, a **regenerative braking system** is installed. Explain how the system works. (2 marks)

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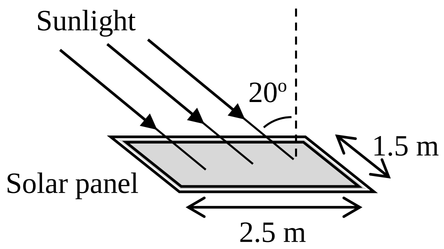
(b) The solar panels on the vehicle's roof provide some power to the vehicle's systems. The sunlight of solar power 1200 W m^{-2} shining onto the solar panel at an angle of 20° with the normal of the panel as shown in Figure 3.2. The size of the solar panel is 1.5 m × 2.5 m and the overall efficiency in charging the battery by the solar panel is 15 %. The battery is now 90 % full.

Figure 3.2



Estimate the time required to fully recharge the battery by the solar panel. (3 marks)

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END OF PAPER

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Answer written on this page will not be marked.

List of data, formulae and relationships

Data

molar gas constant	$R = 8.31\ \text{J mol}^{-1}\ \text{K}^{-1}$	
Avogadro constant	$N_A = 6.02\times10^{23}\ \text{mol}^{-1}$	
acceleration due to gravity	$g = 9.81\ \text{m s}^{-2}$ (close to the Earth)	
universal gravitational constant	$G = 6.67\times10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$	
speed of light in vacuum	$c = 3.00\times10^{8}\ \text{m s}^{-1}$	
charge of electron	$e = 1.60\times10^{-19}\ \text{C}$	
electron rest mass	$m_e = 9.11\times10^{-31}\ \text{kg}$	
permittivity of free space	$\varepsilon_o = 8.85\times10^{-12}\ \text{C}^2\ \text{N}^{-1}\ \text{m}^{-2}$	
permeability of free space	$\mu_o = 4\pi\times10^{-7}\ \text{H m}^{-1}$	
atomic mass unit	$u = 1.661\times10^{-27}\ \text{kg}$	(1 u is equivalent to 931 MeV)
astronomical unit	$AU = 1.50\times10^{11}\ \text{m}$	
light year	$ly = 9.46\times10^{15}\ \text{m}$	
parsec	$pc = 3.09\times10^{16}\ \text{m} = 3.26\ \text{ly} = 206265\ \text{AU}$	
Stefan constant	$\sigma = 5.67\times10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$	
Planck constant	$h = 6.63\times10^{-34}\ \text{J s}$	

Rectilinear motion

For uniformly accelerated motion:

$$v = u + at$$

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

$$v^2 - u^2 = 2as$$

Mathematics

Equation of 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
$\left\lvert\frac{\Delta f}{f_o}\right\rvert \approx \frac{v}{c} \approx \left\lvert\frac{\Delta\lambda}{\lambda_o}\right\rvert$	Doppler effect

Energy and Use of Energy

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

Atomic World

$\frac{1}{2}m_e v_{\max}^2 = hf - \Phi$	Einstein's photoelectric equation
$E_n = \frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_o^2}\right\} = -\frac{13.6}{n^2}eV$	energy level equation for hydrogen atom
$\lambda = \frac{h}{p} = \frac{h}{mv}$	de Broglie formula
$\theta = \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)

Medical Physics

$\theta = \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)
$power = \frac{1}{f}$	power of lens
$L = 10\log\frac{I}{I_o}$	intensity level (dB)
$Z = \rho c$	acoustic impedance
$\alpha = \frac{I_r}{I_o} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$	intensity reflection coefficient
$I = I_o e^{-\mu x}$	transmitted intensity through a medium

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 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
B2.	$moment = F \times d$	moment of a force
B3.	$E_p = mgh$	gravitational potential energy
B4.	$E_k = \frac{1}{2}mv^2$	kinetic energy
B5.	$P = Fv = \frac{W}{t}$	mechanical power
B6.	$a = \frac{v^2}{r} = \omega^2 r$	centripetal acceleration
B7.	$F = \frac{Gm_1m_2}{r^2}$	Newton's law of gravitation

C1.	$\Delta y = \frac{\lambda D}{a}$	fringe width in double-slit interference
C2.	$d\sin\theta = n\lambda$	diffraction grating equation
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens

D1.	$F = \frac{Q_1Q_2}{4\pi\varepsilon_o r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\varepsilon_o r^2}$	electric field strength due to a point charge
D3.	$V = \frac{Q}{4\pi\varepsilon_o r}$	electric potential due to a point charge
D4.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D5.	$I = nAvQ$	general current flow equation
D6.	$R = \frac{\rho l}{A}$	resistance and resistivity
D7.	$R = R_1 + R_2$	resistor in series
D8.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistor in parallel
D9.	$P = IV = I^2R$	power in a circuit
D10.	$F = BQv\sin\theta$	force on a moving charge in a magnetic field
D11.	$F = BIl\sin\theta$	force on a current-carrying conductor in a magnetic field
D12.	$V = \frac{BI}{nQt}$	Hall voltage
D13.	$B = \frac{\mu_o I}{2\pi r}$	magnetic field due to a long straight wire
D14.	$B = \frac{\mu_o NI}{l}$	magnetic field inside a long solenoid
D15.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D16.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer

E1.	$N = N_o e^{-kt}$	law of radioactive decay
E2.	$t_{\frac{1}{2}} = \frac{\ln 2}{k}$	half-life and decay constant
E3.	$A = kN$	activity and the number of undecayed nuclei
E4.	$E = mc^2$	mass-energy relationship