PETRUS KY COLLEGE

NEW SOUTH WALES

in partnership with

VIETNAMESE COMMUNITY IN AUSTRALIA

NSW CHAPTER

JULY 2007

PHYSICS - SOLUTION

PRE-TRIAL TEST

HIGHER SCHOOL CERTIFICATE (HSC)

Student Number: | | | | |

Student Name: ______________________

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours and 15 minutes
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data sheet, formulae sheets and Periodic Table are provided at the back of this paper
- Write your Centre Number and Student Number at the top of pages 1 and 8

TOTAL MARKS: 75

Part A – 15 marks
• Attempt Questions 1–15
• Allow about 30 minutes for this part

Part B – 60 marks
• Attempt Questions 16–27
• Allow about 1 hour and 45 minutes for this part

Part A – 15 marks
Attempt Questions 1–15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet.

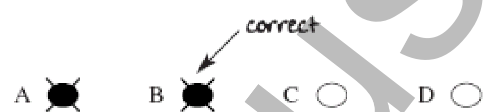
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

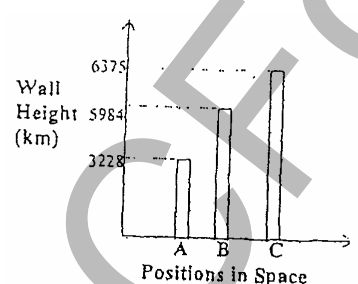
If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.



Question

1 The science fiction author Arthur C. Clarke once stated the energy gain necessary to get into space in terms of the height of the wall you would have to climb under constant sea-level gravity.



A = low Earth orbit

B = geo-stationary orbit

C = beyond Earths gravity

How much energy would need to be expended to lift a satellite, of a total average mass of 1000 kg, from a low earth orbit to a position where it remained in the same relative position above the Earth's equator?

$E = mgh$

(B) 2.7×10^7 J

2 A pendulum can be used to measure the acceleration due to gravity. The equation $T = 2\pi\sqrt{(1/g)}$ is used. At a distance R from the centre of a planet the period of such a pendulum is found to be 10.0 seconds. What will be the period of the pendulum at a distance 2R from the centre of the planet?

At 2R gravity is $\frac{1}{4}$ the strength as at R. This multiplies $1/g$ by 4 and so $\sqrt{1/g}$ increases by a factor of 2

(C) 20 seconds

3 Which of the following is a correct statement about escape velocity?

If the angle is too shallow it will bounce off and if too steep it will heat up too much

(D) The initial velocity which projectiles must have to escape the earth's gravitational field.

4 In the slingshot effect a space probe swings around behind a planet and emerges with increased momentum and kinetic energy. Which of the following is the ultimate source of that energy?

The planet slows down (negligibly) thus losing kinetic energy

(C) The kinetic energy of the planet.

5 Which of the following was not a postulated property of the aether which was investigated in the Michelson-Morley experiment?

The aether was thought to be invisible

(B) It was the medium carrying light waves which made the aether visible.

6 Which of the following is the best description of the outcome of the Michelson-Morley experiment?

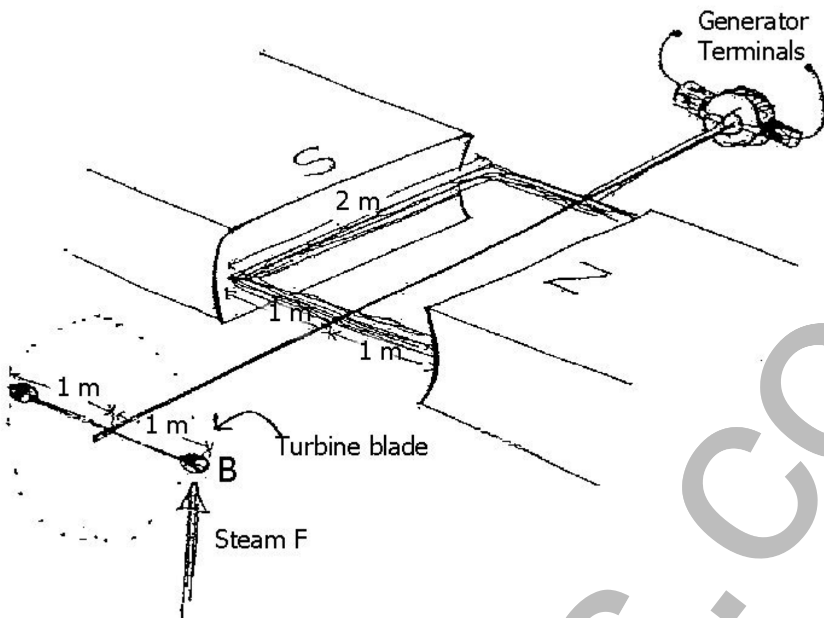
It obtained the null results thus failed to detect any motion through the aether

(A) It failed to detect any motion of the earth relative to the aether

7 Refer to the diagram below, and assume frictionless bearings.

F is the only force being applied to the blade of a steam driven turbine in an early power station.

What magnitude of force F must the steam apply at B to produce the torque necessary to generate a current of 15A in a 500 turn coil which is in a magnetic field of 5T?



Apply the formula ~~$\tau = nBiA$~~ , and $F = nBil = 1.5\ 10^5$ N. , $\tau = Fd$.

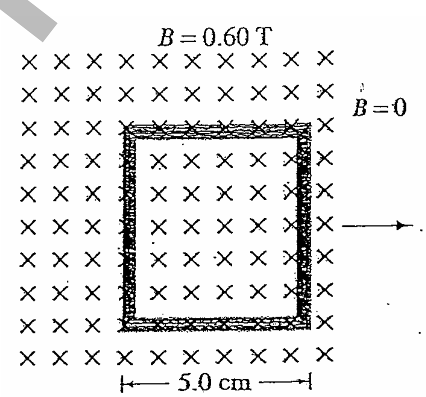
(D) 1.5 x 10^5 N

8 A field of magnetic flux density (magnetic field intensity) 4 T could be formed by a magnetic flux of 2 Wb passing through a circular coil. What is the radius of the coil?

Apply $\Phi_B = BA$ where $A = \pi R^2$

(B) 0.4 m

9



Faraday's Law can be expressed as $\boldsymbol{\varepsilon} = -\Delta \Phi_B / \Delta t$. Where $\boldsymbol{\varepsilon}$ = induced emf, $\Delta \Phi_B$ = change in magnetic flux, Δt = change in time. The square metallic coil (see diagram above) has 100 loops and is in a magnetic fie1d where B = 0.60 T. Over a period of 0.50 s it is pulled smoothly to the right into a region where B = 0. What will be the change in the magnetic flux through the square coil, the emf induced and the direction of the induced (conventional) current?

from the formula and right hand rule (RHR).

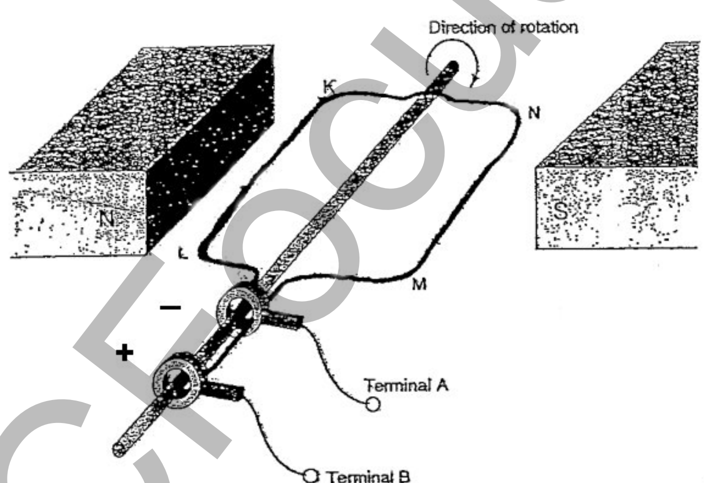
(D) -1.5×10^{-3} Wb, 0.3 V, clockwise

10 Which of the following alternatives best describes what a simple, 240V, 50Hz, AC motor will do when switched on and allowed to run at the rate of the current supplied?

AC motor rotates at 50 revolutions per second or 3,000 revolutions per minute
If slower speeds are required, they are uses a speed-reducing gearbox, that was found in electric clocks, electric drills, fans....

(A) Spin near 3000 revolutions per minute

11 Which of the following statements best describes the generator in the diagram below?



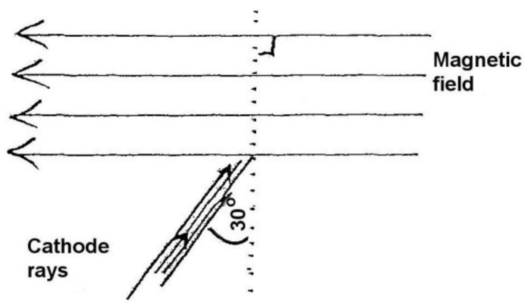
(C) This is an AC generator and at the instant shown in the diagram Terminal A is negative.

12 In an ideal situation there should be no power loss when changing from one voltage to another. That is, the primary power will be equal to the secondary power, or $P_P = P_S$.

In these circumstances it is also possible to calculate the secondary current, I_S. Which equation below allows I_S to be calculated correctly?

(A) $I_s = I_p n_p / n_s$

13 Cathode rays enter a 0.1 T magnetic field at an angle of 30° and at 5.0×10^6 ms^{-1} as shown in the diagram below. What is the force on each electron in the beam as it enters The magnetic field?



Apply $F = Bqv$ (where $q = 1.6\ 10^{-19}$ C, $B = 0.1$ T, $v = 5\ 10^6\ ms^{-1}$.

(B) 6.9×10^{-14} N into the page

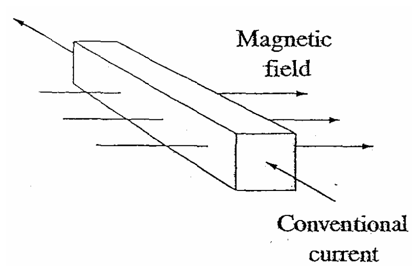
14 An FM radio station transmits at a frequency of 102.8 MHz.

What is the energy, in joules, of each photon emitted by the transmitter?

$E = hf = 6.626\ 10^{-34} \times 102.8 \cdot 10^{6} = 6.812 \cdot 10^{-26}$ J

(B) 6.812×10^{-26}

15 A current is passed along a square semiconductor rod as shown. Half of the current is carried by electrons and half by holes. A magnetic field is then applied to the rod at right angles to its axis.



Which of the following correctly describes the movement of the electrons and holes in the rod when the magnetic field is applied?

positive holes flowing in one direction, electrons flowing in the other direction, will experience a to the same side of the rod.

(C) They move to the same side of the rod.

Physics

Student Number: [ ][ ][ ][ ]

Part B — 60 marks

Attempt Questions 16—27

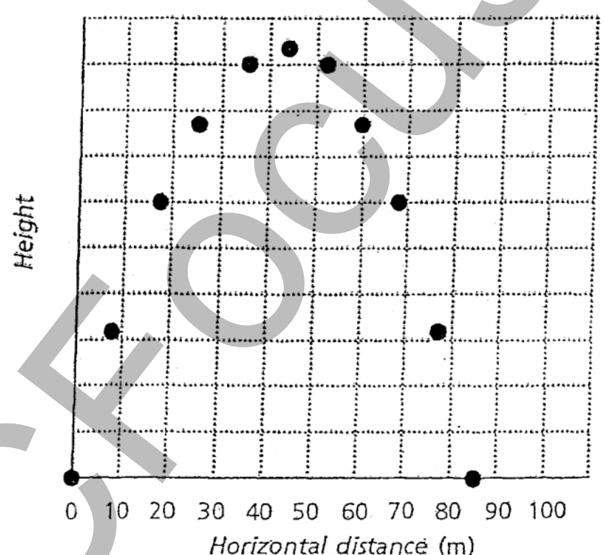
Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question **Marks**

16 Figure 3.21 represents a stroboscope photograph of an object projected from a level surface. The stroboscope was flashing at 1.0 flash per second (a frequency of 1.0 Hz). The vertical scale is deliberately not shown, since to do so would allow a simple method to be used. **4**



(a) What was the time of flight? 1

There are 11 points at 1second intervals. Therefore the time of flight is 10.0 sec.

(b) What is the horizontal component of the object's velocity during flight? 1

The object impacts at 86 m · in 10sec. Then the horizontal component of velocity is

$V_x = \frac{s}{t} = \frac{86\ m}{10\ sec} = 8.6\ m s^{-1}$

(c) What was the vertical component of its initial velocity ? 1

The object reaches maximum height at $t = 5$ sec and when $v_y = 0$

$$v_y = u_y + at$$
$$0 = u_y - 9.8 \times 5.0$$
$$u_y = 49.0\,ms^{-1}$$

The vertical component of velocity is $u_y = 49.0\,ms^{-1}$.

(d) What was the maximum height reached by the object ? 2

At maximum height the vertical component of the velocity is zero

$$v_y^2 = u_y^2 - 2gS_y = 0$$
$$49^2 = 2 \times 9.8 \times S_y$$
$$\text{Therefore } S_y = \frac{2401}{19.8} = 123\,m$$

17 **5**

(a) Explain how the mass and radius of a planet affects the escape velocity of a rocket that is to be launched from its surface. 2

Escape velocity is the vertical velocity that a projectile would need to just escape the gravitational field of a planet. It is given by the equation

$$V_{esc} = \sqrt{\frac{2G\,m_{planet}}{r_{planet}}} \quad \text{So} \quad V_{esc} \propto m_{planet}^{\frac{1}{2}} \quad (\propto : \text{means proportional})$$
$$V_{esc} \propto r_{planet}^{-\frac{1}{2}}.$$

(b) Isaac Newton hypothesised about the motion of a projectile launched horizontally from a mountain top. Outline Newton's ideas that led to the concept of escape velocity. 3

Isaac Newton said that,

if a projectile (ie stone) thrown fast enough then, as the stone falls, the Earth's surface curves away, so that the falling stone never lands on the ground and orbits the Earth. It was only a thought experiment

- If this specific velocity exceeded slightly, the object will follow an eliptical orbit around the Earth
- If this specific velocity exceeded further, the object will follow a parabolic or hyperbolic path away from the earth
- To escape the Earth's gravitational field, the initial velocity required to achieve this is known as escape velocity.

18 **5**

(a) For a satellite undergoing circular motion around a planet, the centripetal force is provided by the gravitational force. Equate centripetal force and Newton's law of universal gravitation to verify that orbital velocity, 3

$$V = \sqrt{\frac{Gm_{planet}}{r_{orbit}}}$$

Centripetal force $F_c = \frac{m_{sate.} v^2}{r}$

Gravitational force $F_g = \frac{G\, m_{sate.} \cdot m_{earth}}{r^2}$

$F_c = F_g = \frac{m_{sate.} v^2}{r} = \frac{G\, m_{sate} \cdot m_{earth}}{r^2}$

Rearranging $v = \sqrt{\frac{G\, m_{earth}}{r}}$

where r = radius of Earth + altitude
$= 6.38 \cdot 10^6$ m + altitude
$m_{earth} = 5.97 \cdot 10^{24}$ Kg
$G = 6.67 \cdot 10^{-11}$ Nm^2Kg^{-1}.

(b) Use the expression from part (a) of this question to calculate the orbital velocity for a satellite moving around the Earth in a circular orbit at an altitude of 300 km. 2

(Use radius of Earth = 6378 km)

Given $G = 6.67 \cdot 10^{-11}$ Nm^2Kg^{-1}
$m_{earth} = 5.97 \cdot 10^{24}$ Kg
$r = 6378\,000 + 300\,000 = 6{,}678{,}000$ m
$V = \sqrt{\frac{6.67 \cdot 10^{-11} \cdot 5.97 \cdot 10^{24}}{6.678 \cdot 10^6}} = \sqrt{5.97 \cdot 10^7} = 7726.58$ m/s

19 **6**

(a) Explain what is meant by the 'equivalence between mass and energy . 2

a) . Einstein made an inference and stated that the mass (or inertia) of the object contain the extra energy.
. Relativity results in a new definition of energy as follows $E = E_k + mc^2$
where E = total energy
E_k = Kinetic energy
m = mass
c = speed of light

- when an object is stationary, $E_K = 0$, it still has some energy due to its mass. This is called its mass energy or rest energy $E = mc^2$

  where E = rest energy (J).

- This famous equation states clearly that there is an equivalence between mass and energy – that mass has an energy equivalent and vice versa.

(b) Most celestial objects outside our Solar System are too distant to reach at current maximum speeds. Discuss the prospect of near light-speed space travel to such destinations with reference to relativistic changes in mass, time and length. 4

celestial object (ie Proxima Centauri) at a speed of 0.1 c or 10% of the speed of light

How long would such a journey take?

Distance to Proxima ≈ 4 LY = $3.7869 \cdot 10^{13}$ Km

Speed of 0.1c = $1.08 \cdot 10^8$ km h^{-1}

Time taken = $\frac{d}{v} = \frac{3.7869 \cdot 10^{13} \text{ km}}{1.08 \cdot 10^8 \text{ km h}^{-1}}$ = 350640 hrs = 40 years

A simpler calculation = $\frac{4c \text{ years}}{0.1c}$ = 40 years.

* if t_v = 40 years, the rest time t_0 lapsed on the spacecraft can be calculated

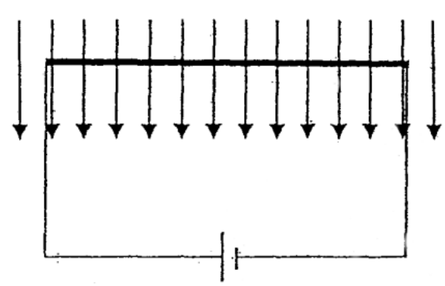
$$t_v = \frac{t_0}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \Rightarrow t_0 = t_v\sqrt{1-\left(\frac{v}{c}\right)^2} = 40\sqrt{1-(0.1)^2} = 39.799 \text{ years}$$
$$= 39 \text{ years } 292 \text{ days.}$$

The spacecraft reaches its destination 73.25 days or two-and-half months, short of 40 years.

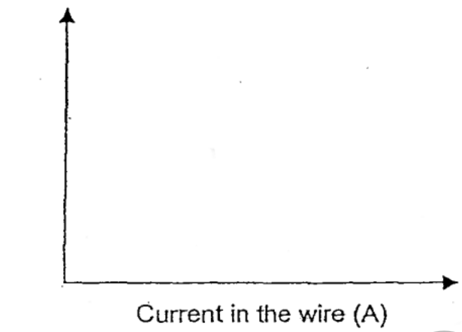
Method 2: Length contraction
$$L_v = L_0\sqrt{1-\left(\frac{v}{c}\right)^2} = 4\sqrt{1-(0.1)^2}$$
$$= 3.9799 \text{ LY.}$$
$$\text{time} = \frac{\text{distance}}{\text{speed}} = \frac{3.9799 \text{ c years}}{0.1c}$$
$$= 39.799 \text{ years} = 39 \text{ years } 292 \text{ days}$$

This example illustrates the influence that relativity can have upon space travel when speeds become "relativistic"

20 A current-carrying conductor is placed in, and perpendicular to, a uniform magnetic field which is represented by the arrows, in the following diagram: **4**

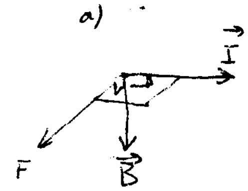


(a) On the axes below sketch a graph that shows how the magnitude of force on the wire would vary if the current in the wire was increased. 1



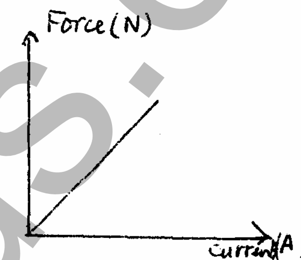
20.

a)



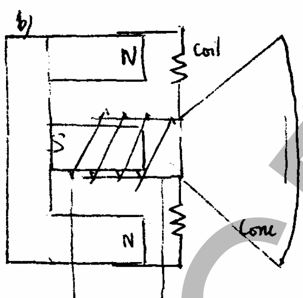
From $F = Bil$

$F \propto i$



(b) Describe how a varying current is used to produce sound in a loudspeaker. 3

b)



A loudspeaker changes electrical energy to sound energy using the force on a current-carrying wire in a field B. (See Fig).

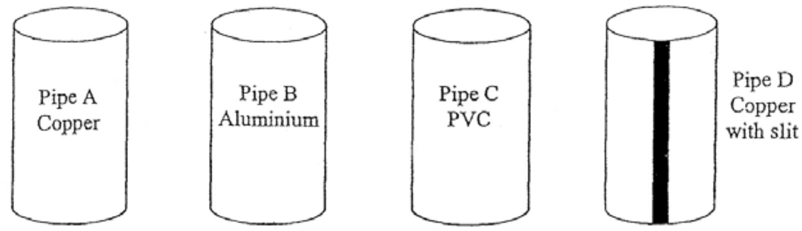
The force is exerted on the coil because it is in a magnetic field B.

The force pushes the coil either into or out of the B. magnetic field depending on the direction of the current.

The motion of the coil cause the cone to vibrate, creating sound waves in the air

The varying current is also used to produce sound because current is proportional to the force that pushes the coil.

21 Students carried out an experiment where they took four pipes and dropped a magnet through them, timing how long it took the magnet to fall. Pipe A was solid copper, Pipe B was solid aluminium, Pipe C was solid PVC and Pipe D was copper with a vertical slit the length of the pipe. 5



The students' results showed that the time taken for the magnet to fall through the PVC was equivalent to the time taken to freefall the same distance. Pipe D was the next shortest time followed by Pipe B and finally Pipe A. The time taken to pass through Pipe A was almost three times the time of freefall.

Explain the students' results in this experiment with reference to Lenz's Law.

The time taken to fall for the magnet was in order of decreasing (shortened time),

A > B > D > PVC

Pipe A copper allows the emf induced to create eddy currents that will oppose its motion.

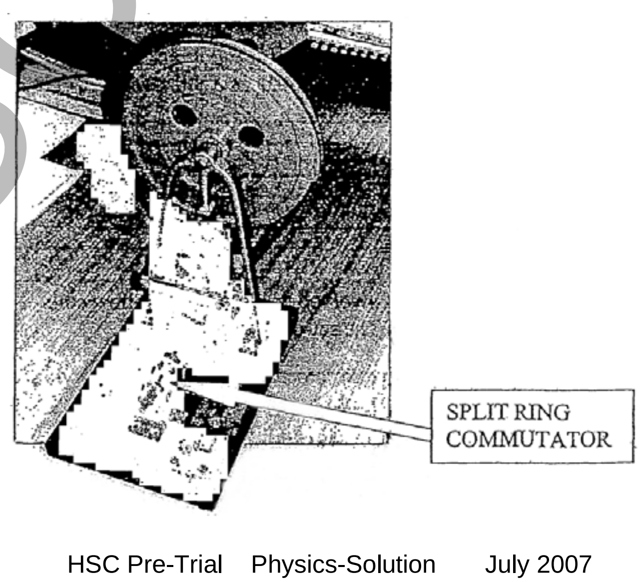
Pipe B alluminium allows the emf induced to create eddy currents, however it is not as strong as copper. It has a higher resistance than copper.

Pipe D of the copper slit only, the emf although established but does not have a complete circuit

Pipe C of PVC, no charge is available to move, no emf, drops down the quickest.

Lenz's law states that an induced current will form that creates a magnetic field to oppose the original change in flux

22 Below is a photograph of a hand-operated AC/DC generator. **5**

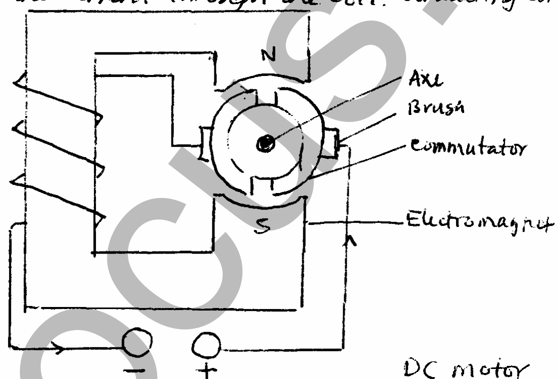


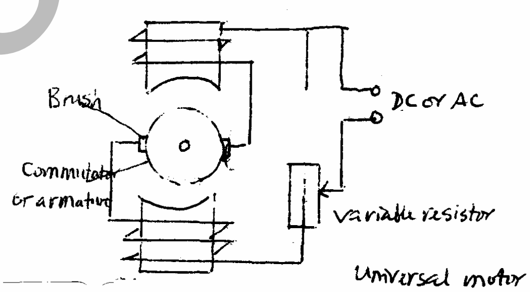
(a) Identify the function of the split-ring commutator in this generator. 1

The commutator is a mechanical switch that automatically changes the direction of the current flowing through the coil when the torque falls to zero.
The slit ring commutator consists of a split metal ring, each part of which is connected to either end of the coil.

(b) Compare a DC generator to a DC motor 4

As the coil rotates, first one ring and then the other make contact with a brush. This reverse the direction of the current through the coil. Conducting contacts called brushes connect the commutator to the DC source of emf.





23 Explain how an understanding of black body radiation changed the direction of scientific thinking in the early twentieth century. **3**

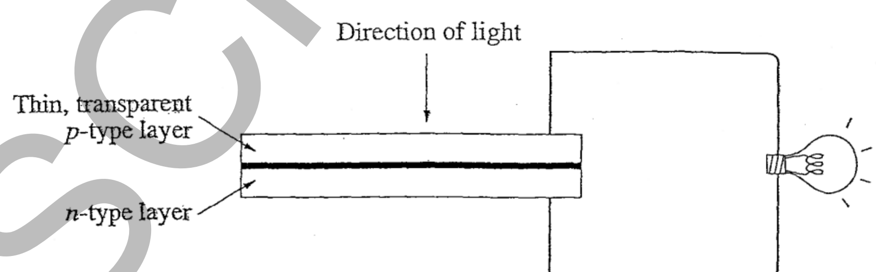
- Planck suggested that the power radiated from a heated object varies with wavelength (λ) and temperature (T). Usually they (λ, T) depend on the characteristics of the object.
- However, the radiation emitted through a small opening from a cavity does not depend either on the material of its wall or on the shape of the cavity and the hole.
- The cavity radiation obeys a universal law of nature and acts as a perfect blackbody: a perfect absorber and emitter with emissivity equal to 1.
- Planck assumed that the radiation in the cavity was emitted and absorbed by atomic oscillators in the walls of the cavity with two unique characteristics:

  1. The oscillators could only have energies given by $E = nhf$ ($n = 0, 1, 2, 3, 4 \ldots$)
  2. The oscillators could emit energy only in quantized amount $E_{n+1} - E_n = (n+1)hf - nhf = hf$

24 Draw a table to classify and qualitatively compare copper, silicon and glass in terms of the relative number of free electrons that can drift between atoms. **4**

Material	Type	Number of free atoms	Comparison.
copper	conductor	lots	Only a small amount of energy will be able to move large amount of electrons to the conduction band and between atoms.
silicon	Semiconductor	few	A bit more energy than the above (Cu) will be able to move electrons to the conduction band and between atoms.
Glass	insulator	none	Very large amount of energy to move electrons between atoms. In an insulator the electrons are held tightly to the atoms

25 An example of a solar cell is shown below. **6**

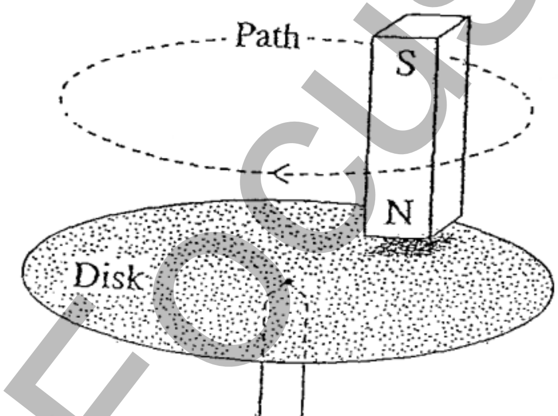


The solar cell is able to produce a current due to the photoelectric effect and the electrical properties of the n-type and p-type layers.

Use this information to outline the process by which light shining on the solar cell produces an electric current that can light up a light globe.

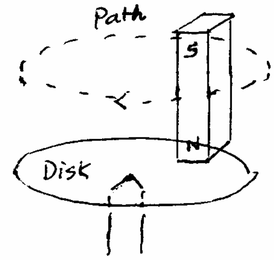
Light falling on the solar cell produces a current is initiated by the photo electric effect.
when a photon of sufficient energy is absorbed by an electron in the semiconductor layers it creates a free electron and a hole.
At the junction between the layers of p and n-type, an electric field has been established by the extra electrons in the lattice n-type drifting across the boundary to fill holes of p-type lattice.
This electric field leads to the photoelectrons produced drifting towards the n-type while the holes drift in the opposite direction.
This establishes a potential difference between p and n-type layers.
Such that connection to the external circuit will allow a current to flow

26 A non-magnetic metal disk is balanced on a support as shown in the diagram below. The disk is initially stationary. A magnet is moved in a circular path just above the surface of the disk, without touching it. The disk begins to spin. **5**



(a) Explain how this demonstration works, and predict which direction the disk will spin 3

The disk begins to rotate in the same direction as the magnet. This demonstrates the principle to the operation of the induction motor.
An induction motor is an AC machine in which torque is produced by the interaction of a rotating magnetic field produced by the stator and currents induced in the rotor.



(b) The principle involved in the demonstration above has been incorporated 2 into the workings of domestic electrical appliances such as hair-dryers and power-tools. Describe one energy transfer and one energy transformation that occurs when a domestic hair-dryer is operating.

- Energy transfers happen when energy moves from one place to another
- Energy transformations that occur when an electric appliancer is operating depend on what the machine is doing.
- Consider the operation of a hair dryer:
  - The electric motor transforms electrical energy into mechanical energy (the rotor spins)
  - Some electrical energy is also transformed into internal energy due to Eddy curr.
  - The mechanical energy of the rotor is transformed into sound and internal energy within the motor, and into the kinetic energy of air particles by a fan that is attached to the shaft of the rotor.
  - Energy is transferred from the motor to the air by the rotor shaft and the fan. The air passes through a heating element where electrical energy is transformed into internal energy and light energy.

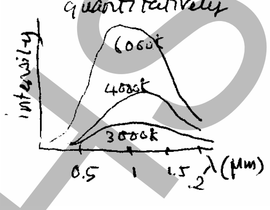
  Internal energy is then transferred out of the dryer by direct conduction to the air particles and by convection as the air particles carry the energy from the dryer.

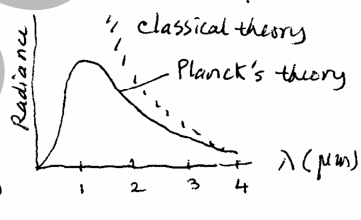
27 **7**

(a) Describe the radiation produced when the walls of a black body cavity are heated. 2

Black body absorbs all radiation that falls on it. That energy is spread throughout the object. The cavity walls get hotter, then the emission of more intense, shorter wavelength radiation from the cavity occurs. The shape of the radiation v/s intensity curves on the graphs

that they created a problem that the intensity and wavelength variations that occurs quantitatively





(b) Identify Planck's hypothesis which was used to explain black body radiation. 1

Planck's explanation is that the exchanged energy is in multiples of a small "lump'
Each lump is characteristic of each frequency of radiation emitted.
This small average packet is known as a "quantum" of energy, that could be described by hf, $E = hf$ where E : energy (J)
h : Planck's constant $= 6.63 \times 10^{-34}$ Js
f : frequency (Hz)

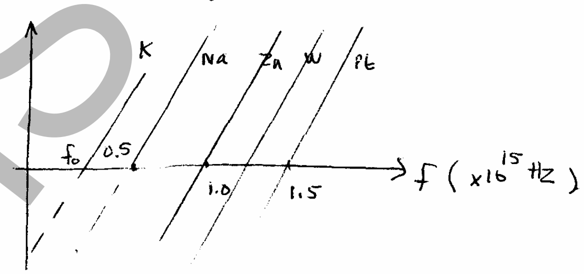
(c) Describe how Einstein used Planck's hypothesis to develop a new model of light. 1

Einstein explained the photoelectric effect successfully.
He used Planck's theory in which the particles of light (photons), carried energy that could be transferred to matter, and proposed the following assumptions.

1. Light exists as photons with energy $E = hf$
2. Light intensity depends on the number of photons
3. Photons with the highest energy correspond to light of the highest frequency
4. To produce the photoelectric effect, the energy required to release the electron from the surface is called the work function.
5. If the energy of the photon is greater than the work function, the addition energy of the photon will provide the kinetic energy of the photoelectrons
$E = hf = W + E_K$.

(d) Einstein used this new model to explain the way photoelectrons are produced from a metal surface by incident light. Explain how he used this model to account for the effect of light frequency and light intensity on the photoelectrons. 3

Different metals hold electrons with different forces.
To provide the photons of light at reasonable frequency will have sufficient energy to overcome the binding energy holding the electrons in the surface
The graph shows the energy with which the photoelectrons are emitted and the threshold frequency for different metals was indicated.



Einstein's photoelectric equation:
$E = W + E_K$ where W : work function
E_K : kinetic energy

FORMULAE SHEET

$v = f\lambda$

$I \propto \frac{1}{d^2}$

$\frac{v_1}{v_2} = \frac{\sin i}{\sin r}$

$E = \frac{F}{q}$

$R = \frac{V}{I}$

$P = VI$

$\text{Energy} = VIt$

$v_{av} = \frac{\Delta r}{\Delta t}$

$a_{av} = \frac{\Delta v}{\Delta t}$ therefore $a_{av} = \frac{v - u}{t}$

$\Sigma F = ma$

$F = \frac{mv^2}{r}$

$E_k = \frac{1}{2}mv^2$

$W = Fs$

$p = mv$

$\text{Impulse} = Ft$

$E_p = -G\frac{m_1 m_2}{r}$

$F = mg$

$v_x^{\ 2} = u_x^{\ 2}$

$v = u + at$

$v_y^{\ 2} = u_y^{\ 2} + 2a_y \Delta y$

$\Delta x = u_x t$

$\Delta y = u_y t + \frac{1}{2}a_y t^2$

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

$F = \frac{Gm_1 m_2}{d^2}$

$E = mc^2$

$l_v = l_0\sqrt{1 - \frac{v^2}{c^2}}$

$t_v = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$

$m_v = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$

FORMULAE SHEET

$$\frac{F}{l} = k\frac{I_1 I_2}{d}$$

$$F = BIl\sin\theta$$

$$\tau = Fd$$

$$\tau = nBIA\cos\theta$$

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

$$d = \frac{1}{p}$$

$$M = m - 5\log\left(\frac{d}{10}\right)$$

$$\frac{I_A}{I_B} = 100^{(m_B - m_A)/5}$$

$$m_1 + m_2 = \frac{4\pi^2 r^3}{GT^2}$$

$$F = qvB\sin\theta$$

$$E = \frac{V}{d}$$

$$E = hf$$

$$c = f\lambda$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$\lambda = \frac{h}{mv}$$

$$Z = \rho v$$

$$\frac{I_r}{I_0} = \frac{[Z_2 - Z_1]^2}{[Z_2 + Z_1]^2}$$

$$A_0 = \frac{V_{\text{out}}}{V_{\text{in}}}$$

$$\frac{V_{\text{out}}}{V_{\text{in}}} = -\frac{R_{\text{f}}}{R_{\text{i}}}$$

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79	
	Au	Symbol of element
Atomic Weight	197.0	
	Gold	Name of element

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.41 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [97.91] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanides	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po [209.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223.0] Francium	88 Ra [226.0] Radium	89–103 Actinides	104 Rf [261.1] Rutherfordium	105 Db [262.1] Dubnium	106 Sg [266.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [144.9] Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinides

89 Ac [227.0] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237.0] Neptunium	94 Pu [244.1] Plutonium	95 Am [243.1] Americium	96 Cm [247.1] Curium	97 Bk [247.1] Berkelium	98 Cf [251.1] Californium	99 Es [252.1] Einsteinium	100 Fm [257.1] Fermium	101 Md [258.1] Mendelevium	102 No [259.1] Nobelium	103 Lr [262.1] Lawrencium

Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ^{237}Np and ^{99}Tc.