SUBJECT:	Physics
PAPER NUMBER:	IIB
DATE:	1st September 2014
TIME:	4:00 p.m. to 6:00 p.m.

Answer all Questions.
You are requested to show your working and to write the units where necessary.
When necessary, take g, acceleration due to gravity, as 10m/s^2.

Density	$m = \rho V$		
Pressure	$F = p A$	$p = \rho g h$	
Moments	Moment = F × perpendicular distance		
Energy and Work	$PE = m g h$	$KE = \frac{1}{2} m v^2$	$W = F s$
	Work Done = energy converted		$E = P t$
Force and Motion	$m a$ = unbalanced force	$W = m g$	$v = u + a t$
	average speed = $\frac{\text{total distance}}{\text{total time}}$		$s = (u + v)\frac{t}{2}$
	$v^2 = u^2 + 2 a s$	$s = u t + \frac{1}{2} a t^2$	momentum = m v
Waves	$\eta = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$		$v = f \lambda$
	$\eta = \frac{\text{real depth}}{\text{apparent depth}}$	Magnification = $\frac{\text{image distance}}{\text{object distance}}$	
	Magnification = $\frac{\text{image height}}{\text{object height}}$		$T = \frac{1}{f}$
Electricity	$Q = I t$	$V = I R$	$E = Q V$
	$P = I V$	$R \propto \frac{1}{A}$	$E = I V t$
	$R_{total} = R_1 + R_2 + R_3$	$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$	
Electromagnetism	$\frac{N_p}{N_s} = \frac{V_p}{V_s}$	$V_p I_p = V_s I_s$	
Heat	$Q = m c \Delta\theta$		
Radioactivity	$A = Z + N$		
Other equations	Area of a triangle = $\frac{1}{2} b h$	Area of a trapezium = $\frac{1}{2}(a + b) h$	
	Area of a circle = πr^2		

1. ***This question is about Radioactivity.***

One method that scientists use to date ancient fossils is called carbon dating. All living things on Earth are made up of a small amount of the element Carbon-14.

a. Carbon-14 ($^{14}_{6}C$) decays by emitting beta particles. The symbol for a beta particle is $^{X}_{Y}e$:

i. State the values of X and Y? X ___0___ Y ___-1___.

ii. A beta particle can be stopped by ___a thin sheet of aluminium___.

(3 marks)

b. Carbon-12 ($^{12}_{6}C$) is another atom of the element Carbon. Carbon-12 and Carbon-14 are called isotopes.

i. Isotopes have the same ___proton___ number but different ___mass___ number.

ii. Carbon-14 is said to be radioactive. Its nucleus can be shown as ___unstable___.

(3 marks)

c. Apart from beta particles, radioactive nuclei can also emit:

i. ___α___ particles;

ii. ___γ___ radiation.

(2 marks)

d. Compare the ionising power of the radioactive emissions mentioned in c (i) and c (ii).

α particles are the most ionising

γ Radiation is the least ionising

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e. Give one way in which radioactive emissions can be beneficial and one way in which they can be harmful.

Beneficial: Carbon dating, Quality Control, treating cancer

Harmful: Nuclear Bombs

(2 marks)

f. A GM tube connected to a counter is used to measure the radioactivity emitted from a substance. After the substance has been removed, the counter still gives a reading. Explain.

background radiation including the remaining percentage of radioactive substance that was being used (depending on the no. of half lives that passed).

(2 marks)

g. Carbon-14 has a half-life of 5,730 years.

i. Define the term half-life of a radioactive substance.

the time taken for a radioactive sample to decay by half

(2 marks)

ii. A fossil was found to be 17,190 years old. Determine what fraction of the element Carbon-14 was found in the fossil after all these years.

17190 ÷ 5730 = 3 half lives

∴ 1 ÷ 2 = ½ ÷ 2 = ¼ ÷ 2 = ⅛

(2 marks)

iii. Another fossil, found to be 11,460 years old, contained 24 atoms of Carbon-14. What was the original amount of atoms of Carbon-14, when the organism died?

11460 ÷ 5730 = 2 half lives

24 × 2 = 48 ×2 = 96 atoms

(2 marks)

2. *This question is about electric circuits.*

Andrea connected two bulbs, P and Q, each of resistance 4 Ω and a 6 V cell in two different ways as shown below.

Figure A

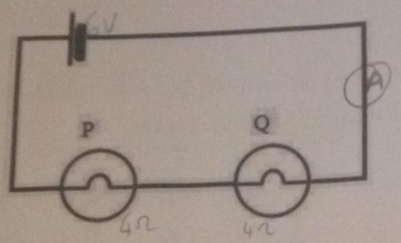
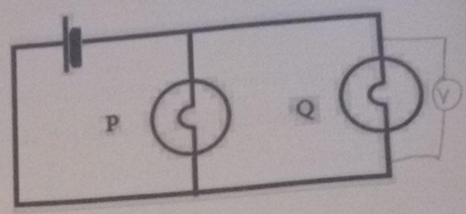


Figure B



a. In Figure A the bulbs are connected in series, while in Figure B the bulbs are connected in parallel. (2 marks)

b. Calculate the total resistance of the two bulbs in both figures.

Figure A: $R_T = 4\Omega + 4\Omega = 8\Omega$

Figure B: $\frac{1}{R_T} = \frac{1}{4} + \frac{1}{4} = \frac{2}{4} = \frac{1}{2}$

$\therefore R_T = 2\Omega$

(3 marks)

c. Draw on the diagram of Figure A an ammeter which can be used to measure the total current flowing in the circuit. (2 marks)

d. Calculate the total amount of current flowing in Figure A.

$V = IR$ $\quad 6 = I_T \times 8$ $\quad I_T = 0.75$ Amps

$6 = I_T \times R_T$ $\quad 6/8 = I_T$

(2 marks)

e. A voltmeter is an instrument to measure potential difference.

i. Draw the symbol of a voltmeter to show how it should be connected properly in Figure B to find the voltage across bulb Q. (2 marks)

ii. What is the voltage across bulb Q in Figure B? Explain how you arrived to your answer.

V_Q is 6V since the voltage across the parallel branches remain constant

(2 marks)

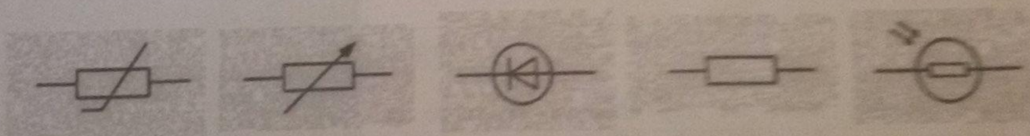
f. Underline the correct term from the suggested words in the brackets.

i. If a third bulb R of resistance 4 Ω, is connected in Figure A similarly to bulbs P and Q, the voltage across bulbs P, Q and R will (increase, decrease, remain the same) and the current through each bulb will (increase, decrease, remain the same).

ii. If a third bulb R of resistance 4 Ω, is connected in Figure B in the same manner as bulb P an Q, the voltage across bulbs P, Q and R will (increase, decrease, remain the same) and th current through each bulb will (increase, decrease, remain the same).

(4 mar

g. Which of following diagrams represent an electrical component which:



A B C D E

i. allows current to flow in one direction only? C

ii. decreases its resistance when its temperature rises? A

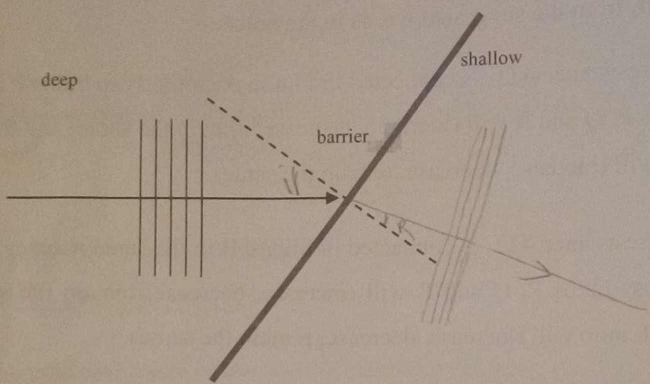
iii. allows more current to flow when exposed to light? E

(3 ma

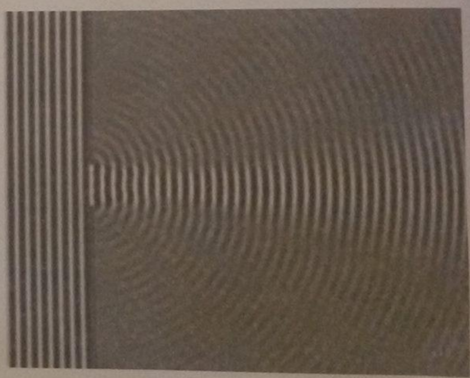
3. ***This question is about water waves.***

In a ripple tank experiment, an electric motor causes a bar to vibrate which then produces plane waves.

a. A block of perspex is placed at the bottom of the ripple tank such that there is a deep and a shallow section of water. Continue the path of the water waves in the shallower region. On your diagram show clearly the angle of incidence and the angle of refraction, and the wavelengths of the water waves in the shallower part. (4 marks)



b. The apparatus is rearranged and the water waves in the diagram could be observed.



i. What do we call this phenomenon?

Diffracton

(1 mark)

ii. State whether there are any changes, (increase or decrease or no changes) in the following properties of a wave after it passes through the barrier.

- speed of the waves Same
- frequency Same
- wavelength. Same

(3 marks)

c. State and explain the effect if any, on each of the physical quantities below, when doubling the speed of the motor of the ripple tank.

- speed of the waves Same

- frequency of waves ______ increases
- wavelength of waves ______ decreases

(3 mark

John and Rita wish to calculate the speed of the water waves at a particular moment.

i. Describe a simple experiment on how can they find the speed of the water waves.

(4 mar

i. State any formula they need to use to find the speed.

(1 ma

ii. State two precautions that should be taken.

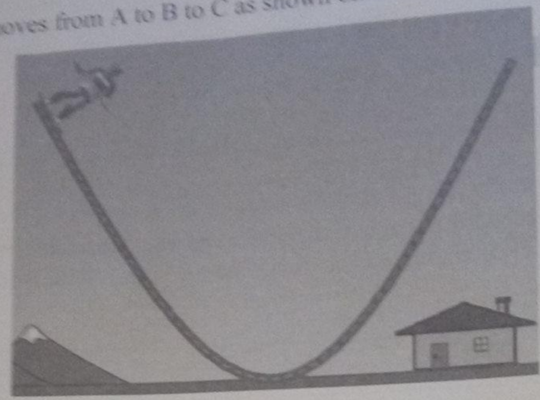
(2 mar

v. Wavefronts were measured such that the distance between two successive crests was 2 c
The frequency of the water waves is 0.5 Hz. Calculate the velocity of the water waves.

$V = f\lambda = 0.5\,(0.02) = 0.01$ m/s

4. ***This question is about energy and momentum.***

a. A skateboarder moves from A to B to C as shown on the diagram below.



75
700
10500

i. If the skateboarder is 15 m high above the ground at A and the mass of the skateboarder is 70 kg, calculate the potential energy of the skateboarder at A.

PE = mgh = 70 × 10 × 15
= 10500 J

(2 marks)

ii. Assuming that all the energy is conserved, state the kinetic energy of the skateboarder at B.

10,500 J since PE lost = KE gained

(1 mark)

iii. The actual velocity of the skateboarder at B is 14 m/s. Calculate the kinetic energy of the skateboarder at B.

KE = ½mv² = ½ × 70 × 14² = J

(2 marks)

iv. Give **two** reasons why the potential energy of the skateboarder at A is **not** totally converted to kinetic energy at B.

Because some energy is wasted into heat + sound due to air resistance + friction.

(2 marks)

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v. A second skateboarder has a smaller mass than the first skateboarder. If the second skateboarder starts from the same height, how will the velocity at B change with respect to the velocity of the first skateboarder? Explain.

↓P.E = mgh   the velocity of B compared to that of A

↓KE = ½mv²   is much less since he gains less P.E &

∴ he has less energy to be converted to KE.

and since velocity² is ∝ to KE then velocity of B decreases considerably

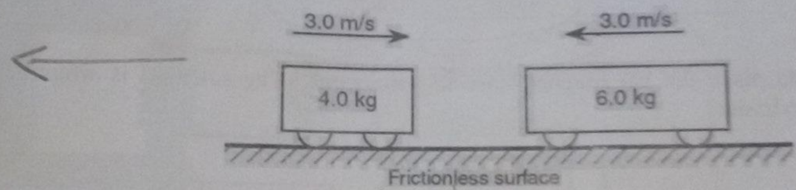
(2 marks)

b. Complete the law of conservation of momentum.

The law of conservation of momentum states that total momentum before a collision is equal to the total momentum after a collision.

(2 marks)

c. Two trolleys moving in opposite directions collide and move together.



i. Give the units of momentum. kg m/s (1 mark)

ii. Calculate the **total** momentum of the two trolleys before collision.

Total mom = $mom_4 + mom_6 = (mv)_4 + (mv)_6$

$= (4 \times 3) + (6 \times 3) = 12 - 18 = -6$ kg m/s

(3 marks)

iii. Draw an arrow on the diagram to show the direction in which the trolleys move after collision. Explain.

Since momentum of the 6kg is bigger, then they will move to the same side of the 6 kg trolley

(2 marks)

iv. Calculate the common velocity of the trolleys moving together after collision.

$mu_1 + mu_2 = (m_1 + m_2)v$ $v = -6/10 = -0.6$ m/s

$-6 = (10)v$

(2 marks)

v. Explain why the trolleys are made to move on a frictionless surface.

to eliminate friction, ∴ no energy loss

(1 mark)

5. ***This question is about magnets and electromagnetism.***

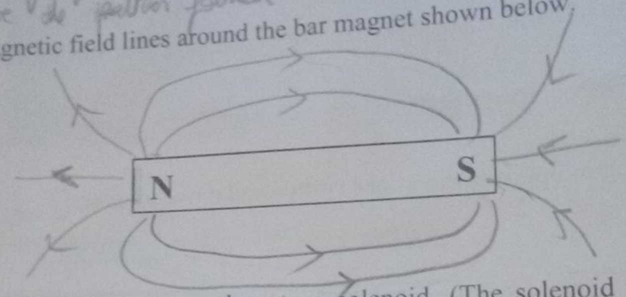
a. Jeremy and Charlotte investigate the magnetic field around a bar magnet.

i. Describe a simple experiment to observe the magnetic field pattern around a bar magnet.

- place a sheet of blank paper on plastic stands + place magnet beneath
- sprinkle iron filings on the paper, tap the paper to spread them + observe the pattern formed

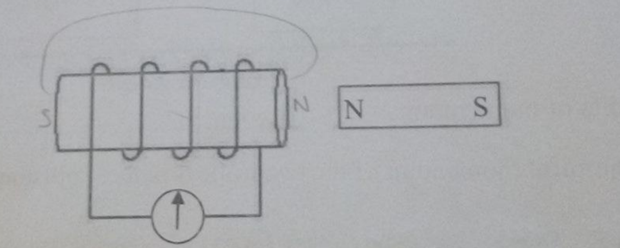
(2 marks)

ii. Draw the magnetic field lines around the bar magnet shown below.



(2 marks)

b. The students place the bar magnet close to a solenoid. (The solenoid is wound on a hollo[w] cardboard cylinder)



i. What is observed as soon as they push the magnet into the solenoid?

the arrow will move to one side indicating a current

(1 m[ark])

ii. What is observed as soon as they remove the magnet out of the solenoid?

the arrow will move to the opposite side

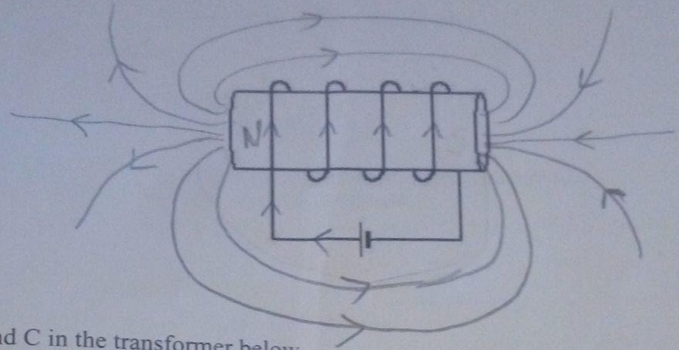
(2 m[arks])

iii. Name **two** changes that can be done to increase the effect observed.

- move the magnet in with a greater speed
- increase the no. of turns of solenoid

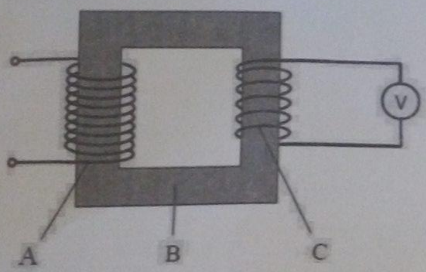
(2 m[arks])

iv. Draw the magnetic field lines around a current carrying solenoid. Mark also the position of the North pole.



(3 marks)

c. i. Label A, B and C in the transformer below.



A - primary coil

B - iron core

C - secondary coil

(3 marks)

ii. The 240V mains electricity supply is connected to A, which has 400 turns. C has 100 turns. Calculate the voltage across C.

$\frac{N_p}{N_s} = \frac{V_p}{V_s}$ $\frac{400}{100} = \frac{240}{V}$ $V = \frac{240 \times 100}{400} = 60V$

(2 marks)

iii. The transformer is 90% efficient. What does this mean?

only 90% of 60V actually are induced in C since there would be some energy losses

(2 marks)

iv. Name **one** use of a step-down transformer.

to supply power to a laptop.

(1 mark)