Mark Scheme – Semester One Examination (July Intake 2012)

1. Base unit : ampere B1
Derived quantity: charge/resistance B1
Derived unit : volt/ohm B1
Base quantity : current B1
[If two answers are given to any of the above, both must be correct to gain the mark]

2.(a)(i) distance = area of small triangle = 0.5 x 1 s x 10 m s^{-1} = 5 m A1
(ii) distance fallen = area of large triangle = 0.5 x 3 s x 30 m s^{-1} = 45 m C1
total distance = 45 m + 5 m = 50 m A1
[Allow ecf from a(i)]
(b) 40 m A1
Below (point of release) or minus sign A1
[Allow ecf from a(i)and (ii)]
(c) Line drawn parallel to time axis extending from t = 0 B1
[Above or below the time axis]
The line drawn parallel to the time axis extends from 0 s to 4 s B1
[If line continues beyond or stops short of 4 s do not give this mark]
Acceleration shown as **minus** 9.81/10 ms^{-2} B1

3.(a) weight = mg B1
= 0.108 N A1
(b)(i) Arrow pointing down at (7.2→7.5 cm) **labelled** weight/ 0.108 N/W/mg A1
[Check by eyes]
(ii)0.108 x (0.9 → 1.2 cm) = *W* x (3.6 → 3.8 cm)
use principle of moments C1
[Give this mark even if the distances are wrong, but must use 0.108N/ ecf their value of weight]
Correct distances used must be <u>0.9 → 1.2</u> cm and <u>3.6 → 3.8</u> cm C1
[no ecf from b(i)]
$W = (0.0275 \pm 0.02)$ N A1
(c)(i) At the pivot, upwards. A1
(ii)magnitude = 0.108 + 0.0275 = 0.14 ± 0.02N A1
(iii)Line of action acts through pivot/force is through or at pivot/
(perpendicular) distance to pivot is zero. B1

4.(a)(i) Gravitational potential energy A1
(ii)Kinetic energy A1
(b) *EITHER*
Energy can be neither created nor destroyed B1

OR
Energy cannot be created/destroyed / total energy is not lost/gained
<u>*AND*</u>
merely transformed from one form to another / in a closed/isolated system B1
(c) $P = Fv$
$1.7 \times 10^9 = 3.5 \times 10^8 \times v$ C1

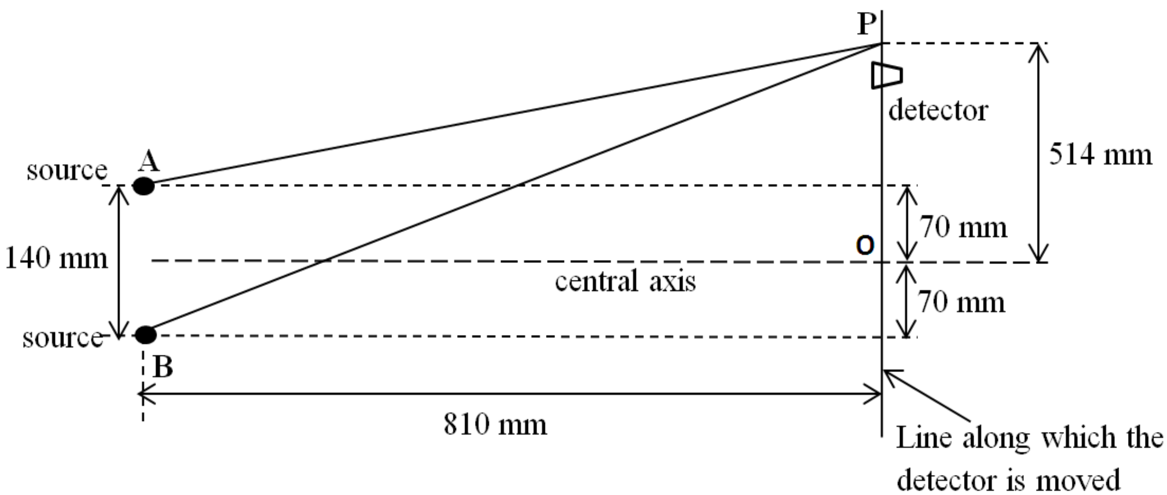
	$v = 4.86\ ms^{-1}$	A1
(d)	Time = $(7 \times 10^6)/390$ = 17,949 s (= 299 min) (= 5 h)	A1
(e)	Mass of water = $7 \times 10^6 \times 10^3 = 6.9 \times 10^9$ kg	C1
	Work done = $6.9 \times 10^9 \times 9.81 \times 500$	A1
	$= 3.43 \times 10^{13}$ J	A1

5. (a) State what is meant by the diffraction of a wave.

Spreading of waves ---------- (B1)

when passed through a gap / aperture/opening/obstacles/slits/edge/ --------- (B1)

(b) Two microwave source **A** and **B** are in phase with one another. They emit waves of equal amplitude and of wavelength 30.0 mm. They are placed 140 mm apart and at a distance of 810 mm from a line **OP** along which a detector is moved, as shown above.



(i) Show that the distance **AP** is 923. 7 mm.

AP = $\sqrt{(810m^2 + 444m^2)}$ --------------- (A1)

AP = 923.7 mm

[1]

(ii) Calculate the number of wavelengths between source **A** and point **P**.

923.7 mm / 30 mm = 30.8 wavelengths ------------------------ (A1)

[1]

(iii) Explain and state the intensity of microwaves that will be received by the detector when it is at **P**.

n = Path difference / λ = 2.5, since n is 2.5 then it must be a
destructive interference. ----------- (M1)
Thus, intensity will be zero ----------- (A1)

(iv) How many maxima are detected as the detector moves from **P** to the point **O** on the central axis.

3 maxima ---------------------- (A1)

[1]

6. (a) Define **electric field strength.**

Force acting per unit positive charge ------------- (B1) [1]

(b) A proton is moved in vacuum by an electric field of 3.75×10^5 N C^{-1} from A to B, a distance of 8.5 mm as shown in Fig. 6.1.

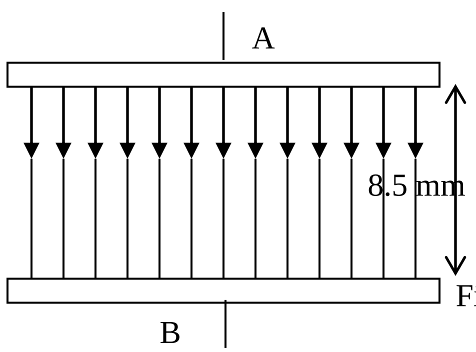


Fig. 6.1

(i) Calculate the potential difference between A and B.

$V = 3.75 \times 10^5 \times 8.5 \times 10^{-3}$ ------------ (C1)

$V = 3.19$ kV ------------ (A1)

[2]

(ii) What is the speed of the proton when it reaches B?

$\frac{1}{2} mv^2 = qV$ ----------------- (C1)

$v = 7.82 \times 10^5$ ms^{-1} ----------------- (A1)

[2]

(iii) State whether A or B is at the lower potential.

B
.... [1]

7. (a) What is meant by an e.m.f of a source of 120 V.

120 J of electrical energy is transferred by the source in driving 1 C of charge round a
.... [2]

(b) 15 identical lamps are connected in series to a 120 V supply. The total power consumed is 38.4 W. Calculate the resistance of a single lamp in the set.

$38.4 = 120^2 / R$

$R = 375\ \Omega$

R for single lamp = 275 / 15 = 25 Ω

[2]

(c) If the set of 15 lamps were to be connected in parallel, what would have been the total power consumed?

Total R = 1.67 Ω

$P = 120^2 / 1.67$

P = 8.64 kW

[2]

8. In the circuit shown in Fig. 8.1, cell A has an e.m.f. of 2.0 V and negligible internal resistance. XY is a uniform wire of length 100cm and resistance 5.0Ω. Cell B has an e.m.f. of 1.5 V and internal resistance 0.80Ω.

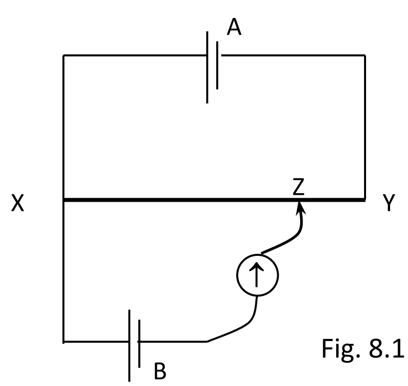


Fig. 8.1

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Calculate the length of XZ required to produce zero deflection in the galvanometer
(i) in the circuit as shown in Fig. 8.1

$V_{XZ} / V_{XY} = L_{XZ} / L_{XY}$

$1.5 / 2.0 = L_{XZ} / 100$ -------------------------------- (C1)

$L_{XZ} = 75$ cm -------------------------------- (A1)

[2]

(ii) when a 1.0 Ω resistor in placed in series with A.

$V_{XY} = (5/6)(2.0) = 1.67$ V -------------------------------- (C1)
$V_{XZ} / V_{XY} = L_{XZ} / L_{XY}$
$1.5 / 1.67 = L_{XZ} / 100$
$L_{XZ} = 90$ cm -------------------------------- (A1)

[2]

(iii) when this resistor is removed from A and place in series with B.

$V_{XZ} / V_{XY} = L_{XZ} / L_{XY}$

$1.5 / 2.0 = L_{XZ} / 100$ -------------------------------- (C1)

$L_{XZ} = 75$ cm -------------------------------- (A1)

[2]

9. (a) Given the approximate values for the radius of a gold atom and the radius of a gold nucleus are 10^{-10} m and 10^{-15} m respectively. The density of gold is 19 000 kgm^{-3}. Estimate the density of a gold nucleus, stating the assumption that you make in your answer.

$\rho_{\text{gold atom}} / \rho_{\text{gold nucleus}} = (r_{\text{gold nucleus}} / r_{\text{gold atom}})^3$

$19\,000 / \rho_{\text{gold nucleus}} = (10^{-15} / 10^{-10})^3$ -------------------------------- (C1)

$\rho_{\text{gold nucleus}} = 1.9 \times 10^{19}$ kgm^{-3} -------------------------------- (A1)

[3]

(b) A nucleus of $^{238}_{92}\text{U}$ absorbs a slow neutron and it subsequently emits two β-particles. Write an equation for this nuclear reaction. Use symbol X to represent the resulting nucleus.

$^{238}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow 2\ ^{0}_{-1}\text{e} + ^{239}_{94}\text{X}$

.... [2]