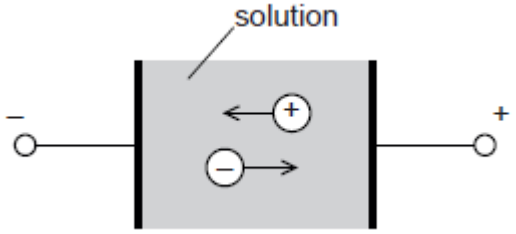
A Level Physics A

H556/02 Exploring physics

Question Set 1

Multiple Choice Questions

1 The diagram below shows the motion of positive and negative particles in a conducting solution.



Which statement is correct?

A The current in the solution is zero.

B The conventional current is to the left.

C The positive particles are always protons.

D The negative particles are always electrons. **[1]**

2 One million electrons travel between two points in a circuit.
The **total** energy gained by the electrons is 1.6×10^{-10} J.

What is the potential difference between the two points?

A 1.6×10^{-16} V

B 1.6×10^{-4} V

C 1.0×10^{3} V

D 1.0×10^{9} V

$V = W/Q$

$V = \frac{1.6 \times 10^{-10}}{1.6 \times 10^{-19} \times 1 \times 10^{6}}$

$V = 1000$ V

[1]

3 Which is **not** a unit of energy?

A kW h

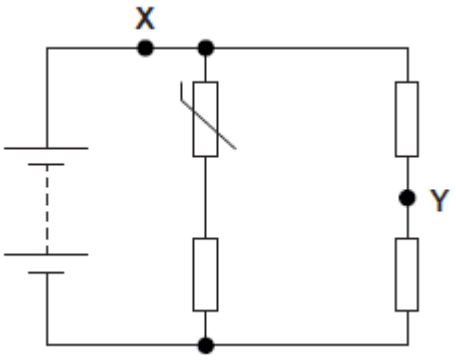
B eV

C J

D W

[1]

4 A circuit is shown below.



The battery has negligible internal resistance. The temperature of the NTC thermistor is **decreased**.

Which of the following statements is/are correct?

1 The current at **X** increases.
2 The current at **Y** remains the same.
3 The potential difference across the thermistor increases.

A 1, 2 and 3

B Only 2 and 3

C Only 3

D Only 2

~ Temp ↓ Resistance ↑
– Total R ↓ so total I ↓ so (1) is incorrect
– I only decreased through loop with thermistor so (2) correct
– R of thermistor has increased by larger proportion than I has decreased, so $V = IR$ V across thermistor increases so (3) correct.

[1]

5 A progressive wave of amplitude *a* has intensity I. This wave combines with another wave of amplitude 0.6*a* at a point in space. The phase difference between the waves is 180°.

What is the resultant intensity of the combined waves in terms of I?

A $0.16I$

B $0.4I$

C $1.6I$

D $2.6I$

Resultant A → Destructive so $a - 0.6a = 0.4a$
Resultant I → proportional to A^2 so $0.4^2a^2 = 0.16a^2 = 0.16I$

[1]

6 Stationary waves are produced in a tube closed at one end and open at the other end. The fundamental frequency is 120 Hz.

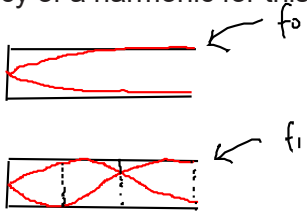
What is a possible frequency of a harmonic for this tube?

A 60 Hz

B 240 Hz

C 360 Hz

D 480 Hz



[must have node at closed end, antinode at open end]

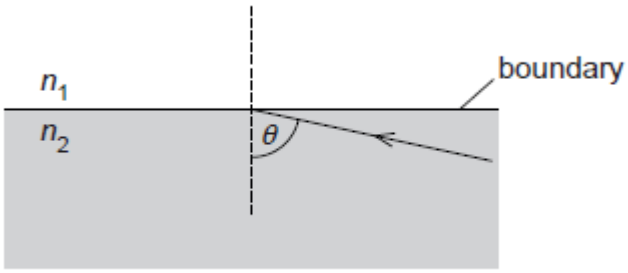
f_1 is 3x more 'bunched' than f_0 over the same length so $f_1 = 3f_0$

$= 3 \times 120$

$= 360$ Hz

[1]

7 A ray of monochromatic light is incident at the boundary between two transparent materials of refractive index n_1 and n_2. The critical angle θ is equal to 80°.



What is the ratio $\frac{n_1}{n_2}$?

A 0.17

B 0.98

C 1.02

D 5.76

At critical angle θ_c →

→ $n_2 \sin\theta_c = n_1 \sin 90$

→ $n_2 \sin\theta_c = n_1$

$\frac{n_1}{n_2} = \sin\theta_c = 0.98$

[1]

8 Which electrical quantity has S.I. units ampere-second (As)?

A charge

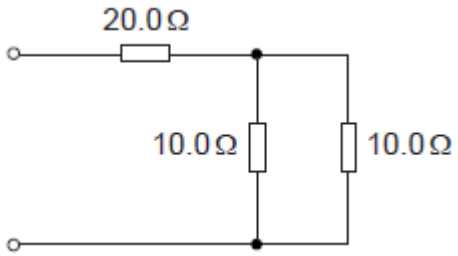
B current

C resistance

D potential difference

[1]

9 Three resistors are connected in a circuit.



The resistance of each resistor is shown in the circuit diagram.

What is the total resistance of this circuit?

A 10.0Ω

B 20.2Ω

C 25.0Ω

D 40.0Ω

Resistors in parallel:

$\frac{1}{R_p} = \frac{1}{10} + \frac{1}{10} = \frac{1}{5}$

$R_p = 5\ \Omega$

$R_T = R_p + 20 = 25.0\ \Omega$

Your answer C **[1]**

10 An electron has a de Broglie wavelength equal to the wavelength of X-rays.

What is the **best** estimate of the momentum of this electron?

A $10^{-30}\,\text{kg m s}^{-1}$

B $10^{-27}\,\text{kg m s}^{-1}$

C $10^{-23}\,\text{kg m s}^{-1}$

D $10^{-18}\,\text{kg m s}^{-1}$

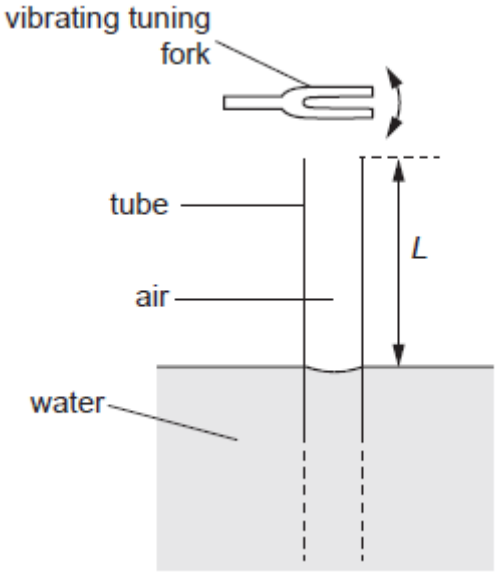
$p = \frac{h}{\lambda} = \frac{6.63 \times 10^{-34}}{1 \times 10^{-10}}$

$= 6.63 \times 10^{-24}$

$\approx 1 \times 10^{-23}$

Your answer C **[1]**

11 A vibrating tuning fork is held above the open end of a long vertical tube. The other end of the tube, which is also open, is immersed in a tank of water. The length *L* of the air column within thetube is changed by raising or lowering the tube.



The wavelength of sound from the vibrating tuning fork is 150.0 cm.

What length *L* of air column will **not** produce a stationary wave within the tube?

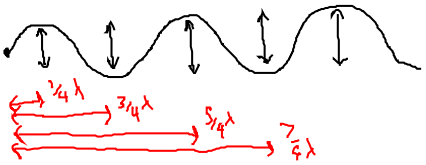
A 37.5 cm

B 75.0 cm

C 112.5 cm

D 187.5 cm

Must have node at closed end, antinode at open end.

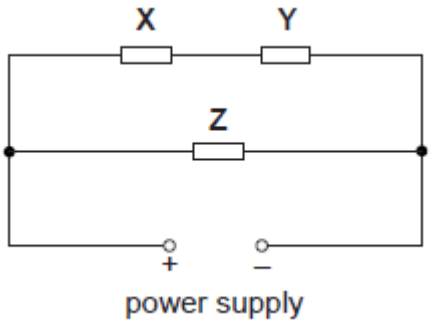


Can only fit waves of $\frac{1}{4}\lambda = 37.5\text{cm}$, $\frac{3}{4}\lambda = 112.5\text{cm}$, $\frac{5}{4}\lambda = 187.5\text{cm}$, $\frac{7}{4}\lambda = 262.5\text{cm}$ and so on.

Your answer [B]

[1]

12 Three identical resistors **X**, **Y** and **Z** are connected to a power supply.



The power dissipated in the resistor **Z** is 24 W.

What is the power dissipated in the resistor **Y**?

A 6.0 W

B 12 W

C 24 W

D 48 W

- If I through Z loop, 0.5 I through XY loop
- V same across both loops, but split across Z components in XY loop so each recieves 0.5 V
- Power across Y → P = Voltage × current = $0.5^2 VI = 0.25VI$
  $= 0.25 \times 24$
  $= 6$

Your answer A

[1]

13 A small loudspeaker emits sound uniformly in all directions.
The amplitude of the sound is 12 μm at a distance of 1.5 m from the loudspeaker.

What is the amplitude of the sound at a distance of 4.5 m from the loudspeaker?

A 1.3 μm

B 4.0 μm

C 6.9 μm

D 12 μm

$A \propto \frac{1}{r}$ so $3 \times$ distance $= \frac{1}{3} A = 4\,\mu m$

Your answer B

[1]

14 Which law indicates that charge is conserved?

A Lenz's law

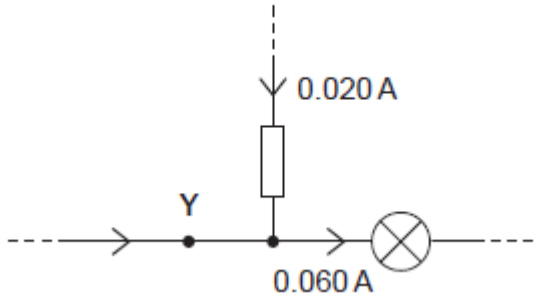
B Coulomb's law

C Kirchhoff's first law

D Faraday's law of electromagnetic induction

Your answer C **[1]**

15 Part of an electric circuit is shown below.



The direction of all the currents and the magnitude of two currents are shown.

How many electrons pass through the point **Y** in 10 s?

A 1.25×10^{18}

B 2.50×10^{18}

C 3.75×10^{18}

D 5.00×10^{18}

By KI I through Y = 0.040 A

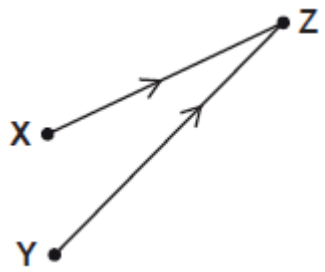
0.04 = 0.04 coulombs / s

$= 0.04 \times \left(\frac{1}{1.6 \times 10^{-19}}\right)$ electrons / second

$= 2.5 \times 10^{17}$ electrons / second

Your answer B **[1]**

16 Coherent radio waves from transmitters **X** and **Y** are emitted in phase. The waves interfere **constructively** at point **Z**.



The distance **XZ** is 16.0 m and the distance **YZ** is 20.0 m.
The radio waves have wavelength λ.

Which value of λ is **not** possible?

Path difference = 4m must be multiple of λ for constructive interference.

A 1.0 m ✓

B 2.0 m ✓

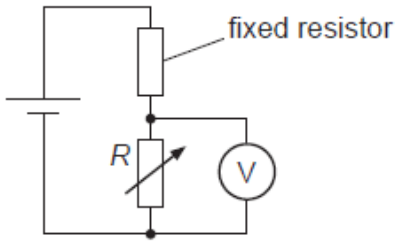
C 3.0 m ×

D 4.0 m ✓

Your answer [C]

[1]

17 A potential divider circuit is shown below.

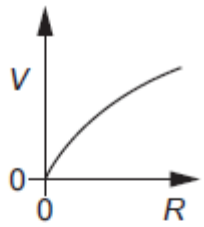


The resistance of the variable resistor is *R*. The potential difference across the variable resistor is *V*.

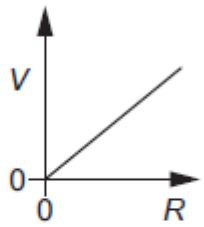
Which graph shows the correct variation with *R* of *V*?

$V = \frac{R\uparrow}{\uparrow R + r} \times \varepsilon$

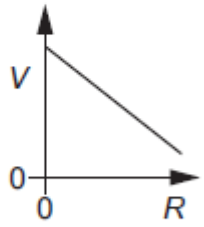
A



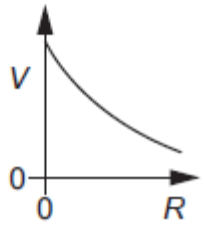
B



C



D



Your answer A **[1]**

18 Wires **P** and **Q**, made from the same metal, are connected in **parallel** across a cell of negligible internal resistance.
The table shows some data.

Wire	Length of wire	Diameter of wire	Mean drift velocity of electrons in the wire / mm s^{-1}
P	L	d	0.60
Q	$3L$	$2d$	v

What is the mean drift velocity v of the electrons in wire **Q**?

A 0.15 mm s^{-1}

B 0.20 mm s^{-1}

C 0.30 mm s^{-1}

D 0.60 mm s^{-1}

$R = \frac{\rho L}{A}$ $\left.\right\}$ $R = \frac{\rho L}{I} nvr$ → $RI = \rho L nvr$ → $V = \rho L nvr$

$I = nAvr$

Sbs parallel so V equal across both → $\rho L_P n v_P r = \rho L_Q n v_Q r$

→ $L_P v_P = L_Q v_Q$

→ $v_Q = \frac{L_P v_P}{L_Q} = \frac{0.6L}{3L} = 0.2$

Your answer B **[1]**

19 Which of the following statements is/are correct about electromagnetic waves?

1 They can be plane polarised.
2 They can be refracted and diffracted.
3 They have the same speed in a vacuum and in glass.

A Only 1

B Only 3

C Only 1 and 2

D 1, 2 and 3

Your answer C **[1]**

Total Marks for Question Set 1: 19