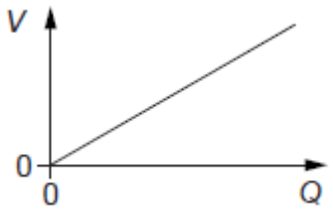
A Level Physics A

H556/02 Exploring physics

Question Set 2

Multiple Choice Questions

1 The graph below shows the variation of potential difference V with charge Q for a capacitor.



Which row is correct for the gradient of the graph and the area under the graph?

	Gradient of graph	**Area under the graph**
A	capacitance^{-1}	work done
B	capacitance^{-1}	permittivity
C	capacitance	power
D	capacitance	energy

Your answer A **[1]**

2 A capacitor discharges through a resistor. At time t = 0, the charge stored by the capacitor is 600 μC. The capacitor loses 5.0 % of its charge every second.

What is the charge **left** on the capacitor at time t = 4.0 s?

A 111 μC

B 120 μC

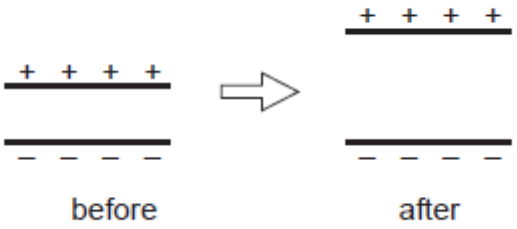
C 480 μC

D 489 μC

$600 \times 0.95^4 = 489\ \mu C$

Your answer D **[1]**

3 Two isolated parallel capacitor plates have an equal and opposite charge.
The separation between the plates is doubled.
The charge on each plate remains the same but the potential difference between the plates doubles.



Which statement is correct?

A The capacitance of the capacitor doubles. $C \propto \frac{1}{d}$ so would halve

B The energy stored by the capacitor is halved. $W \propto V$ so would double

C The permittivity of free space doubles. A constant.

D The electric field strength between the plates remains the same. $E = \frac{V}{d}$ so correct

Your answer [D] **[1]**

4 Which statement is correct?

A Hadrons are made up of protons and neutrons.

B A positron and a proton are examples of leptons.

C The positron and the electron have the same mass.

D The weak nuclear force is responsible for alpha-decay.

Your answer [C] **[1]**

5 An electron moves in a circle of radius 2.0 cm in a uniform magnetic field of flux density 170 mT.

What is the momentum of this electron?

A 3.4×10^{-3} kg m s^{-1}

B 5.4×10^{-17} kg m s^{-1}

C 1.4×10^{-18} kg m s^{-1}

D 5.4×10^{-22} kg m s^{-1}

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

$Be = \frac{mv}{r}$

$Ber = p = 170 \times 10^{-3} \times 1.6 \times 10^{-19} \times 2 \times 10^{-2}$

Your answer D

[1]

6 A proton collides with a stationary oxygen-18 nucleus. The collision produces a fluorine-18 nucleus and particle X.

$$^{1}_{1}p + {}^{18}_{8}O \rightarrow {}^{18}_{9}F + X$$

What is particle X?

A neutron

B proton

C electron

D positron

Inspecting mass numbers : mass = 1 a.u.

Inspecting proton/charge numbers : charge = 0

} neutron

[1]

Your answer A

7 A beam of charged particles is not deflected when it passes through a region where both electric and magnetic fields are present.

Which statement is **not** correct?

A All the particles have the same speed. ✓

B The resultant force on each particle is zero. ✓

C The magnetic force is equal to the electric force on each particle. ✓

D The magnetic field and the electric field are in the same direction. ✗

Your answer D

[1]

8 There are four important attenuation mechanisms by which X-ray photons may interact when they pass through matter.

In which mechanism is the X-ray photon scattered with a longer wavelength?

A simple scattering

B Compton effect

C pair production

D photoelectric effect

Your answer [B] **[1]**

9 An isolated metal sphere is charged using a power supply.

Which single quantity can be used to determine the capacitance of the sphere?

A The diameter of the sphere.

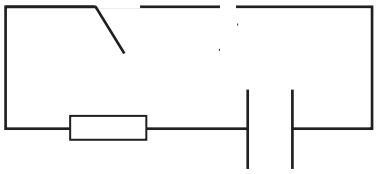
B The charge on the sphere. $C = 4\pi\varepsilon_0 R$

C The resistance of the metal.

D The e.m.f. of the power supply.

Your answer [A] **[1]**

10 A capacitor is charged through a resistor.



The cell has e.m.f. 1.50 V and negligible internal resistance.
The capacitor is initially uncharged. The time constant of the circuit is 100 s.
The switch is closed at time $t = 0$.

What is the potential difference across the capacitor at time $t = 200$ s?

A 0.20 V

B 0.55 V

C 0.95 V

D 1.30 V

$V = V_0(1 - e^{-\frac{t}{RC}})$

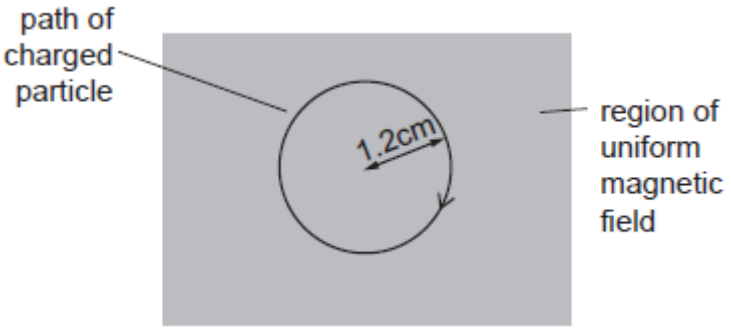
$V_{100} = 1.5(1 - e^{-\frac{200}{100}})$

$V_{200} = 1.30$

Your answer D

[1]

11 A charged particle moves in a circular path of radius 1.2 cm in a uniform magnetic field.



The direction of the magnetic field is perpendicular to the plane of the paper.

The particle has mass m, charge $+Q$ and speed v.

Another particle of mass $3m$, charge $+2Q$ and speed v moves in a circular path of radius R in the same magnetic field.

What is the value of R? $BQv = \frac{mv^2}{r}$

$\rightarrow BQ = \frac{mv}{r}$

$\rightarrow r = \frac{mv}{BQ} = 1.2\,cm$

Replace with new values. $\rightarrow R = \frac{3mv}{2BQ} = \frac{3}{2}r = 1.8\,cm$

A 0.8 cm

B 1.2 cm

C 1.8 cm

D 7.2 cm

Your answer C **[1]**

12 The acoustic impedance Z of a material in the shape of a cube can be determined using the equation

$$Z = \frac{Mc}{L^3}$$

where M is the mass of the material, L is the length of each side of the cube and c is the speed of ultrasound in the material.

The percentage uncertainty in L is 1.2% and the percentage uncertainty in c is 1.8%. The percentage uncertainty in M is negligible.

What is the percentage uncertainty in Z?

A 2.2%

$1.8 + [3 \times 1.2] = 5.4$

B 3.0%

C 4.2%

D 5.4%

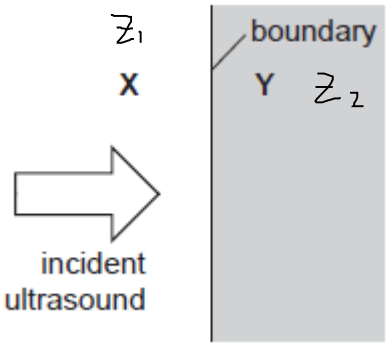
Your answer D

[1]

13 The table shows some data on two tissues in a patient.

Tissue	Density	Acoustic impedance
X	ρ	$1.5Z$
Y	1.3ρ	Z

Ultrasound in tissue **X** is incident at the boundary between the tissues **X** and **Y**.



What is the percentage of the ultrasound intensity reflected at the boundary?

$$\frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2} = \frac{(1 - 1.5)^2}{(1 + 1.5)^2} = 0.04$$

A 1.7 %

B 4.0 %

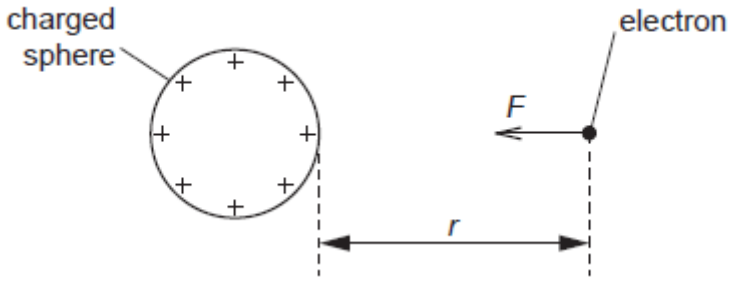
C 13 %

D 20 %

Your answer B

[1]

14 An electron is released at a distance *r* from the surface of a positively charged sphere. It is attracted towards the centre of the sphere and moves until it touches the surface.



Which of the following statements is/are correct?

1 The area under the *F* against *r* graph is equal to work done on the electron. ✓

2 The electric field strength *E* at distance *r* is equal to $\frac{F}{1.6 \times 10^{-19}}$. ✓

3 The work done on the electron is equal to *F* x *r*.

X
F changes

A Only 1

B Only 1 and 2

C Only 1 and 3

D 1, 2 and 3

Your answer [B] **[1]**

15 Which lepton is emitted in the decay of an up quark and is affected by a magnetic field?

A neutrino

B electron

C positron

D antineutrino

Your answer [C] **[1]**

16 A contrast material is used while taking an X-ray image of a patient.

Which statement is correct?

A Iodine is a contrast material.

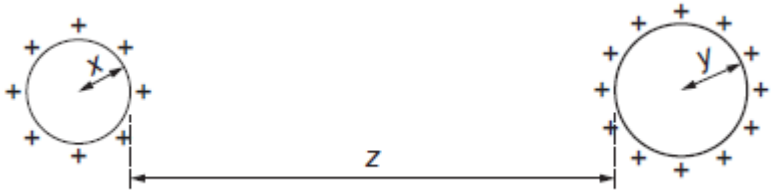
B Technetium is a contrast material.

C A contrast material must have a short half-life.

D A contrast material is used for acoustic matching.

Your answer A **[1]**

17 The diagram below shows two uniformly charged spheres separated by a large distance *z*.



The radius of the small sphere is *x* and the radius of the large sphere is *y*.

Which is the correct distance to use when determining the electric force between the charged spheres?

A *z*

B *x* + *z* Between sphere's centres

C *y* + *z*

D *x* + *y* + *z*

Your answer D **[1]**

18 The electric field strength at a distance of 2.0×10^{-8} m from a nucleus is 3.3×10^{8} N C^{-1}.

What is the charge on the nucleus?

A 1.6×10^{-19} C

B 1.5×10^{-17} C

C 7.3×10^{-10} C

D 3.8×10^{-9} C

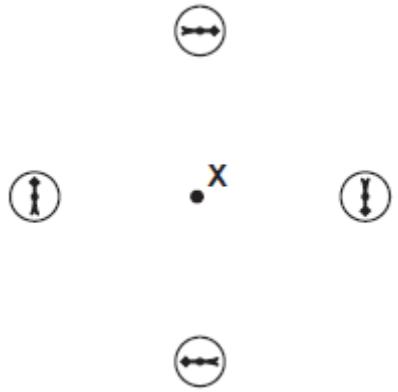
$Q = E 4\pi\varepsilon_0 r^2$

$= 3.3 \times 10^{8} \times 4\pi \times 8.85 \times 10^{-12} \times (2 \times 10^{-8})^2$

$= 1.47 \times 10^{-17}$

Your answer B **[1]**

19 The diagram shows four magnetic compasses placed at the same distance from point **X**.



Which of the following is most likely to be at point **X**?

A permanent magnet

B current-carrying solenoid

C current-carrying flat coil

D straight current-carrying wire , hence a circular field around it.

Your answer D **[1]**

20 A coil with 500 turns is placed in a uniform magnetic field.
The average cross-sectional area of the coil is $3.0 \times 10^{-4}\,m^2$.
The magnetic flux through the plane of the coil is reduced from 1.8×10^{-4} Wb to zero in a time t.
The average electromotive force (e.m.f.) induced across the ends of the coil is 0.75 V.

What is the value of t?

A 3.6×10^{-5} s

B 2.4×10^{-4} s

C 0.12 s

D 8.3 s

$$\mathcal{E} = -NA\frac{\Delta B}{\Delta t}$$

$$0.75 = 500 \times 3\times10^{-4} \times \frac{1.8\times10^{-4}}{\Delta t}$$

$$\Delta t = 3.6\times10^{-5}$$

Your answer A **[1]**

21 The radius of a gold nucleus with 197 nucleons is 7.3×10^{-15} m.

What is the best estimate for the volume of a uranium nucleus with 235 nucleons?

A $1.6 \times 10^{-42}\,m^3$

B $1.9 \times 10^{-42}\,m^3$

C $2.1 \times 10^{-42}\,m^3$

D $2.8 \times 10^{-42}\,m^3$

$R = r_0 A^{1/3}$

For gold → $7.3 \times 10^{-15} = r_0 \sqrt[3]{197}$

$r_0 = 1.25 \times 10^{-15}$

For uranium → $R = 1.25 \times 10^{-15} \sqrt[3]{235}$

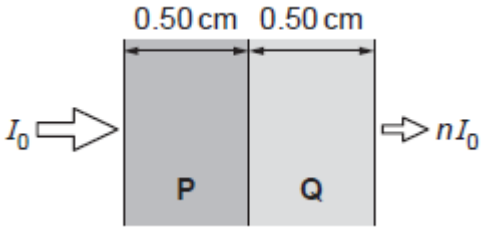
$R = 7.74 \times 10^{-15}$ m

Assuming spherical → $V = \frac{4}{3}\pi R^3$

$= 1.94 \times 10^{-42}\ m^3$

Your answer B **[1]**

22 The intensity of a beam of X-rays incident on material **P** is I_0.
The beam passes through 0.50 cm of material **P** and 0.50 cm of material **Q**.



The absorption (attenuation) coefficients of **P** and **Q** are 0.60 cm^{-1} and 0.20 cm^{-1} respectively.
The intensity of the beam after passing through both **P** and **Q** is nI_0.

What is the value of n?

A 0.67

B 0.74

C 0.82

D 0.90

$I = I_0 e^{-\mu x}$

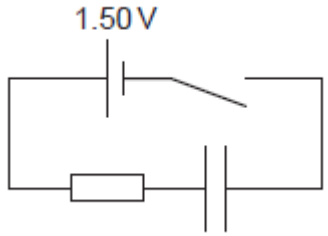
$I_{Boundary} = I_0 e^{-0.6 \times 0.5} = 0.741\, I_0$

$I_{final} = I_{Boundary}\, e^{-0.2 \times 0.5} = 0.741\, I_0 e^{-0.1}$

$= 0.67\, I_0$

Your answer A **[1]**

23 A capacitor is charged through a resistor.



The cell has electromotive force (e.m.f.) 1.50 V and negligible internal resistance.
The time constant of the circuit is 10 s. The switch is closed at time $t = 0$. At time t, the potential difference across the resistor is 0.60 V.

Which expression is correct?

A $0.60 = 1.50e^{-0.10t}$

B $0.90 = 1.50e^{-0.10t}$

C $0.60 = 1.50e^{-10t}$

D $0.60 = 1.50(1-e^{-10t})$

$V = V_0(1 - e^{-t/RC})$

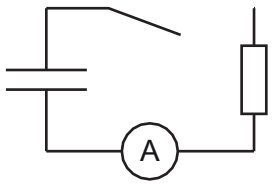
$0.6 = 1.5(1 - e^{-0.1t})$

$0.6 = 1.5 - 1.5e^{-0.1t}$

$0.9 = 1.5e^{-0.1t}$

Your answer B **[1]**

24 A capacitor is discharged through a resistor.



The capacitor is fully charged at time $t = 0$. The time constant of the circuit is 10 s. The switch is closed at time $t = 0$. The current in the resistor is I.

Which row is correct?

	Current I at $t = 0$	Current I at $t = 10$ s
A	maximum ✓	0 ✗
B	maximum ✓	37% of the current at $t = 0$ ✓
C	0 ✗	63% of the current at $t = \infty$ ✗
D	0 ✗	37% of the current at $t = \infty$ ✗

Your answer B **[1]**

25 The number of turns on the coils of four ideal iron-cored transformers **A**, **B**, **C** and **D** are shown in the table below.

Transformer	Number of turns on the secondary coil	Number of turns on the primary coil	$\frac{n_p}{n_s}$
A	100	100	1
B	50	200	4
C	200	50	1/4
D	500	100	1/5

Each transformer is connected in turn to an alternating 240 V supply.

Which transformer will give the largest output current?

Your answer B **[1]**

$$\frac{n_s}{n_p} = \frac{I_p}{I_s}$$

$$I_s = \frac{I_p n_p}{n_s} \propto \frac{n_p}{n_s}$$

Total Marks for Question Set 2: 25