

A-level PHYSICS (7408/2)

Paper 2

Specimen 2014

Morning

Time allowed: 2 hours

Materials

For this paper you must have:

- a pencil
- a ruler
- a calculator
- a data and formulae booklet.

Instructions

- Answer **all** questions.
- Show **all** your working.

Information

- The maximum mark for this paper is 85.

Please write clearly, in block capitals, to allow character computer recognition.

Centre number

Candidate number

Surname

Forename(s)

Candidate signature _____

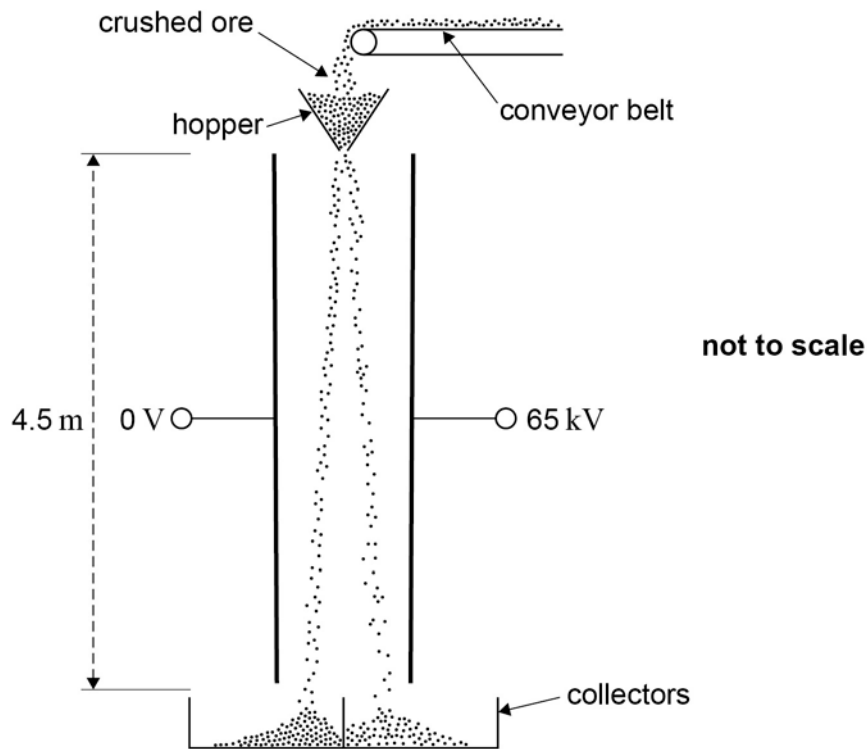
Section A

Answer **all** questions in this section.

0 1

Figure 1 shows a system that separates two minerals from the ore containing them using an electric field.

Figure 1



The crushed particles of the two different minerals gain opposite charges due to friction as they travel along the conveyor belt and through the hopper. When they leave the hopper they fall 4.5 metres between two parallel plates that are separated by 0.35 m.

0 1

. 1

Assume that a particle has zero velocity when it leaves the hopper and enters the region between the plates.

Calculate the time taken for this particle to fall between the plates.

[2 marks]

$$s = \frac{1}{2}gt^2 \quad \text{so} \quad t = \sqrt{(2s / g)}$$

$$t = \sqrt{(2 \times 4.5 / 9.81)} = \sqrt{0.917}$$

$$t = 0.96 \text{ s}$$

time taken = 0.96 s

- 0 1 . 2** A potential difference (pd) of 65 kV is applied between the plates.

Show that when a particle of specific charge $1.2 \times 10^{-6} \text{ C kg}^{-1}$ is between the plates its horizontal acceleration is about 0.2 m s^{-2} .

[3 marks]

$$\text{Field strength } E = V / d = 65 \times 10^3 / 0.35 = 1.86 \times 10^5 \text{ V m}^{-1}$$

$$\text{Force } F = EQ, \text{ so acceleration } a = F / m = E(Q / m)$$

$$a = 1.86 \times 10^5 \times 1.2 \times 10^{-6}$$

$$a = 0.22 \text{ m s}^{-2} \text{ (about } 0.2 \text{ m s}^{-2}\text{)}$$

- 0 1 . 3** Calculate the total horizontal deflection of the particle that occurs when falling between the plates.

[1 mark]

$$s = \frac{1}{2}at^2 = 0.5 \times 0.22 \times 0.96^2$$

$$s = 0.10 \text{ m}$$

$$\text{horizontal deflection} = \underline{0.10} \text{ m}$$

- 0 1 . 4** Explain why the time to fall vertically between the plates is independent of the mass of a particle.

[2 marks]

The only vertical force on a particle is its weight mg , so its

acceleration $= F / m = mg / m = g$: the mass cancels.

The time to fall depends only on the distance and the acceleration,

$t = \sqrt{(2s / g)}$, and m does not appear.

Turn over ►

- 0 1 . 5** State and explain **two** reasons, why the horizontal acceleration of a particle is different for each particle.

[4 marks]

The mass of the particles is not constant: the crushed particles have different sizes, so their masses vary.

The charge on each particle is not constant: the charge gained by friction varies from particle to particle.

Horizontal acceleration $a = Eq / m = (V / d)(q / m)$.

$E = V / d$ is the same for every particle, but q and m are random, so q / m (and so a) is unlikely to be the same for any two particles.

Turn to page 6 for the next question

Turn over for the next question

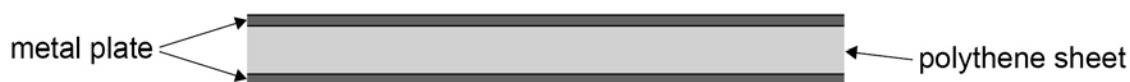
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ANSWER IN THE SPACES PROVIDED**

Turn over ►

0 2

Figure 2 shows a capacitor of capacitance 370 pF. It consists of two parallel metal plates of area 250 cm². A sheet of polythene that has a relative permittivity 2.3 completely fills the gap between the plates.

Figure 2



not to scale

0 2

. 1 Calculate the thickness of the polythene sheet.

[2 marks]

$$C = \epsilon_0 \epsilon_r A / d \quad \text{so} \quad d = \epsilon_0 \epsilon_r A / C$$

$$d = (8.85 \times 10^{-12} \times 2.3 \times 250 \times 10^{-4}) / 370 \times 10^{-12}$$

$$d = 1.38 \times 10^{-3} \text{ m}$$

$$\text{thickness} = \underline{1.4 \times 10^{-3}} \text{ m}$$

0 2

. 2 The capacitor is charged so that there is a potential difference of 35 V between the plates. The charge on the capacitor is then 13 nC and the energy stored is 0.23 μJ.

The supply is now disconnected and the polythene sheet is pulled out from between the plates without discharging or altering the separation of the plates.

Show that the potential difference between the plates increases to about 80 V.

[2 marks]

$$\text{Without the polythene: } C = 370 / 2.3 = 161 \text{ pF}$$

$$\text{The supply is disconnected, so the charge stays at } Q = 13 \text{ nC}$$

$$V = Q / C = 13 \times 10^{-9} / 161 \times 10^{-12}$$

$$V = 81 \text{ V (about 80 V)}$$

- 0 2 . 3** Calculate the energy that is now stored by the capacitor.

[2 marks]

$$E = \frac{1}{2}CV^2 = \frac{1}{2} \times 161 \times 10^{-12} \times 81^2$$

$$E = 5.3 \times 10^{-7} \text{ J} = 0.53 \mu\text{J}$$

energy stored = 0.53 μJ

- 0 2 . 4** Explain why there is an increase in the energy stored by the capacitor when the polythene sheet is pulled out from between the plates.

[2 marks]

The polar molecules align in the field, positive ends toward the negative plate.

Work is done separating the charged surfaces of the polythene from the oppositely charged plates; this work increases the energy stored.

Turn over for the next question

Turn over ►

- 0 3** . **1** State **two** assumptions made about the **motion** of the molecules in a gas in the derivation of the kinetic theory of gases equation. **[2 marks]**

The molecules move about continually in random motion.

They move in straight lines between collisions, and all collisions are elastic.

- 0 3** . **2** Use the kinetic theory of gases to explain why the pressure inside a football increases when the temperature of the air inside it rises. Assume that the volume of the ball remains constant. **[3 marks]**

Higher temperature: mean KE (rms speed) of the molecules increases.

So more collisions per second with the inside of the ball, each with a greater change in momentum. $F = \text{rate of change of momentum}$, so

F and $p = F / A$ increase.

03 . 3

The 'laws of football' require the ball to have a circumference between 680 mm and 700 mm. The pressure of the air in the ball is required to be between 0.60×10^5 Pa and 1.10×10^5 Pa above atmospheric pressure.

A ball is inflated when the atmospheric pressure is 1.00×10^5 Pa and the temperature is 17°C . When inflated the mass of air inside the ball is 11.4 g and the circumference of the ball is 690 mm.

Assume that air behaves as an ideal gas and that the thickness of the material used for the ball is negligible.

Deduce if the inflated ball satisfies the law of football about the pressure.

$$\text{molar mass of air} = 29 \text{ g mol}^{-1}$$

[6 marks]

$$\text{radius } r = 690 \text{ mm} / 2\pi = 110 \text{ mm} = 0.110 \text{ m}$$

$$\text{volume of air } V = (4/3)\pi r^3 = (4/3)\pi \times 0.110^3 = 5.55 \times 10^{-3} \text{ m}^3$$

$$\text{number of moles } n = 11.4 \text{ g} / 29 \text{ g mol}^{-1} = 0.393 \text{ mol}$$

$$\text{temperature } T = 17 + 273 = 290 \text{ K}$$

$$pV = nRT \quad \text{so} \quad p = nRT / V$$

$$p = 0.393 \times 8.31 \times 290 / 5.55 \times 10^{-3}$$

$$p = 1.70 \times 10^5 \text{ Pa}$$

$$\text{Pressure above atmospheric} = 1.70 \times 10^5 - 1.00 \times 10^5 = 0.70 \times 10^5 \text{ Pa}$$

$$0.70 \times 10^5 \text{ Pa lies between } 0.60 \times 10^5 \text{ Pa and } 1.10 \times 10^5 \text{ Pa}$$

(and the circumference, 690 mm, is between 680 mm and 700 mm),

so the inflated ball does satisfy the law of football about the pressure.

Turn over for the next question

Turn over ►

0 4

An ancient sealed flask contains a liquid, assumed to be water. An archaeologist asks a scientist to determine the volume of liquid in the flask without opening the flask. The scientist decides to use a radioactive isotope of sodium ($^{24}_{11}\text{Na}$) that decays with a half-life of 14.8 h.

0 4

. 1

She first mixes a compound that contains 3.0×10^{-10} g of sodium-24 with 1500 cm^3 of water. She then injects 15 cm^3 of the solution into the flask through the seal.

Show that initially about 7.5×10^{10} atoms of sodium-24 are injected into the flask.

[1 mark]

$$\text{atoms in } 3.0 \times 10^{-10} \text{ g} = (3.0 \times 10^{-10} / 24) \times 6.02 \times 10^{23} = 7.53 \times 10^{12}$$

$$\text{fraction injected} = 15 / 1500, \text{ so } N = 7.53 \times 10^{10} \approx 7.5 \times 10^{10}$$

0 4

. 2

Show that the initial activity of the solution that is injected into the flask is about $1 \times 10^6 \text{ Bq}$.

[3 marks]

$$\lambda = \ln 2 / T_{1/2} = 0.693 / (14.8 \times 3600) = 1.30 \times 10^{-5} \text{ s}^{-1}$$

$$A = \lambda N = 1.30 \times 10^{-5} \times 7.5 \times 10^{10}$$

$$A = 9.8 \times 10^5 \text{ Bq (about } 1 \times 10^6 \text{ Bq)}$$

$$\text{activity} = \underline{9.8 \times 10^5} \text{ Bq}$$

0 4 . 3

She waits for 3.5 h to allow the injected solution to mix thoroughly with the liquid in the flask. She then extracts 15 cm^3 of the liquid from the flask and measures its activity which is found to be 3600 Bq.

Calculate the total activity of the sodium-24 in the flask after 3.5 h and hence determine the volume of liquid in the flask.

[3 marks]

$$\lambda = 0.693 / 14.8 \text{ h} = 0.0468 \text{ h}^{-1}$$

$$A = A_0 e^{-\lambda t} = 9.8 \times 10^5 \times e^{-0.0468 \times 3.5}$$

$$\text{total activity in flask } A = 8.32 \times 10^5 \text{ Bq}$$

$$15 \text{ cm}^3 \text{ has activity } 3600 \text{ Bq, so}$$

$$\text{volume of liquid} = (8.32 \times 10^5 / 3600) \times 15$$

$$\text{volume} = 3470 \text{ cm}^3 \quad (3.47 \times 10^{-3} \text{ m}^3)$$

0 4 . 4

The archaeologist obtained an estimate of the volume knowing that similar empty flasks have an average mass of 1.5 kg and that mass of the flask and liquid was 5.2 kg. Compare the estimate that the archaeologist could obtain from these masses with the volume calculated in part 4.3 and account for any difference.

[2 marks]

$$\text{Mass of liquid} = 5.2 - 1.5 = 3.7 \text{ kg, so if it is water the volume is}$$

$$3700 \text{ cm}^3, \text{ compared with } 3470 \text{ cm}^3 \text{ (about } 3500 \text{ cm}^3\text{)}.$$

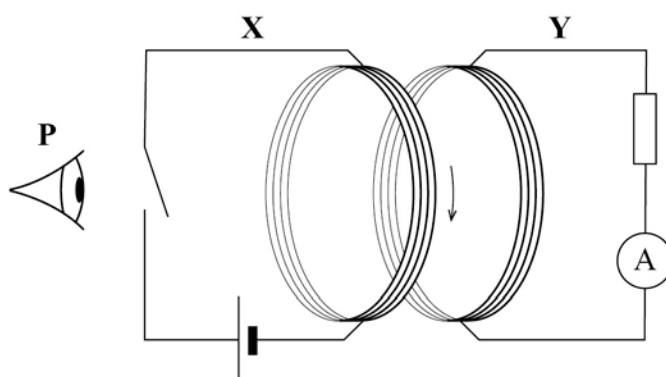
The difference arises because this flask may have more mass than average, or the liquid is not water.

Turn over ►

0 5

Figure 3 shows an arrangement for investigating electromagnetic induction.

Figure 3



When the switch is closed there is a current in the coil in circuit **X**. The current is in a clockwise direction as viewed from position **P**.

Circuit **Y** is viewed from position **P**.

0 5

. 1

Explain how Lenz's law predicts the direction of the induced current when the switch is opened and again when it is closed.

[4 marks]

Lenz's law: the induced current is in a direction such as to oppose the change (in flux) producing it.

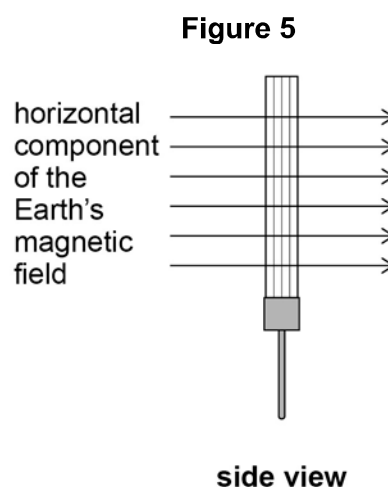
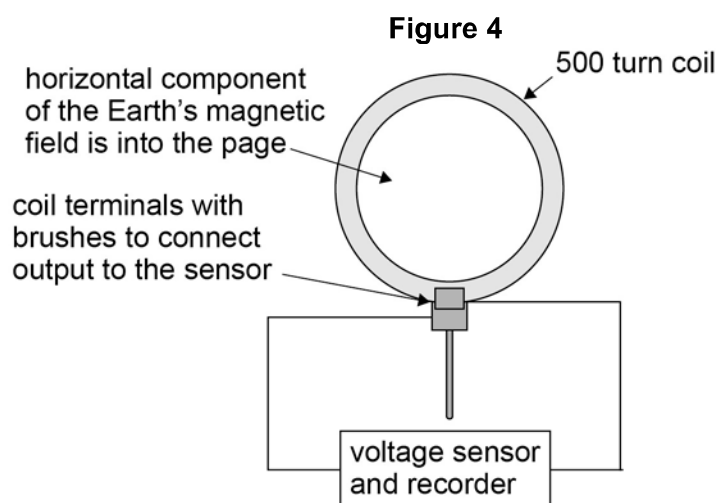
Switch closed (on): the current in X grows, so the magnetic flux through coil Y increases.

The induced current in Y creates flux opposing this increase, so it is in the opposite direction to the current in X; anticlockwise as viewed from P.

Switch opened (off): the current in X falls, so the flux through Y decreases.

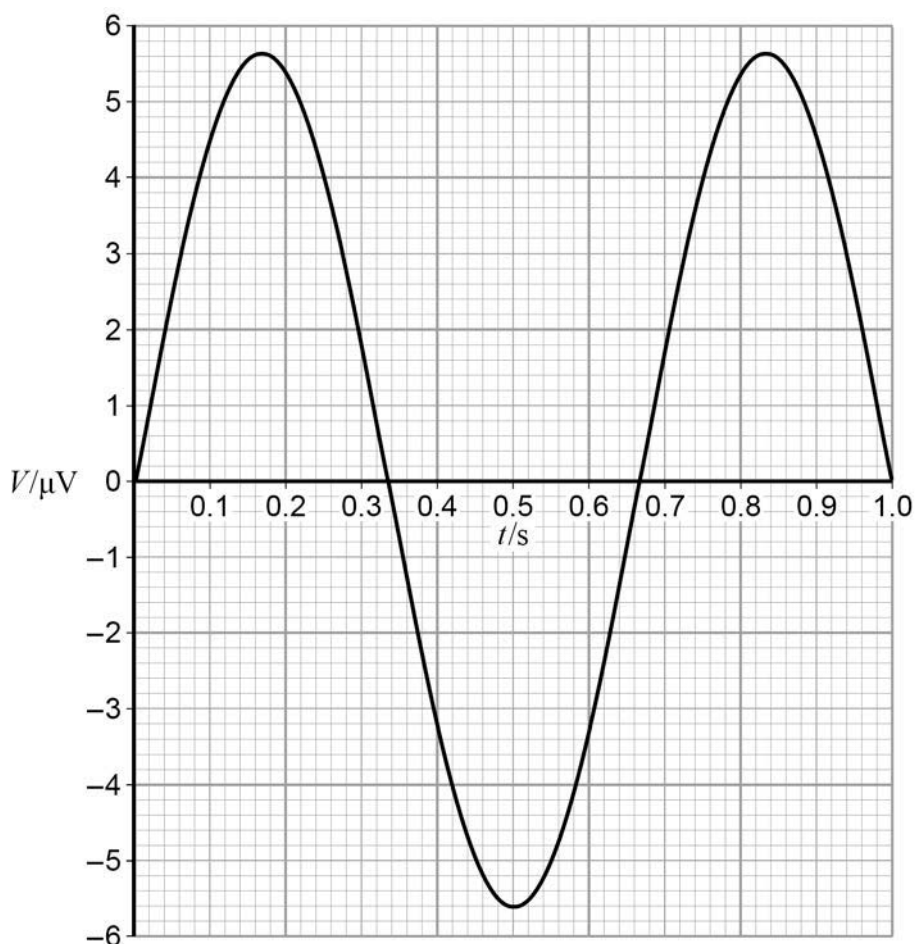
The induced current in Y now creates flux in the same direction, to oppose the decrease, so it travels clockwise as viewed from P.

An 'Earth inductor' consists of a 500 turn coil. **Figure 4** and **Figure 5** shows it set up to measure the horizontal component of the Earth's magnetic field. When the coil is rotated an induced emf is produced.



The mean diameter of the turns on the coil is 35 cm. **Figure 6** shows the output recorded for the variation of potential difference V with time t when the coil is rotated at 1.5 revolutions per second.

Figure 6



Turn over ►

- 0 5 . 2** Determine the flux density, B_H , of the horizontal component of the Earth's magnetic field.

[3 marks]

from Figure 6, peak emf $V_0 = 5.6 \mu\text{V}$; $\omega = 2\pi f = 2\pi \times 1.5 = 9.4 \text{ rad s}^{-1}$

area $A = \pi r^2 = \pi \times 0.175^2 = 0.096 \text{ m}^2$

$V_0 = BAN\omega$ so $B = V_0 / AN\omega$

$B = 5.6 \times 10^{-6} / (0.096 \times 500 \times 9.4)$

$B_H = 1.24 \times 10^{-8} \text{ T} \text{ (12.4 nT)}$

horizontal component of flux density = 1.24×10^{-8} T

0 6

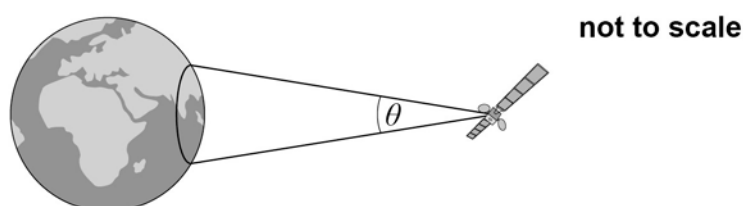
Read the following passage and answer the questions that follow

Satellites used for telecommunications are usually in geostationary orbits. Using suitable dishes to transmit the signals, communication over most of the Earth's surface is possible at all times using only 3 satellites.

Satellites used for meteorological observations and observations of the Earth's surface are usually in low Earth orbits. Polar orbits, in which the satellite passes over the North and South Poles of the Earth, are often used.

One such satellite orbits at a height of about 12 000 km above the Earth's surface circling the Earth at an angular speed of $2.5 \times 10^{-4} \text{ rad s}^{-1}$. The microwave signals from the satellite are transmitted using a dish and can only be received within a limited area, as shown in **Figure 7**.

Figure 7



The signal of wavelength λ is transmitted in a cone of angular width θ , in radian, given by

$$\theta = \frac{\lambda}{d}$$

where d is the diameter of the dish.

The satellite transmits a signal at a frequency of 1100 MHz using a 1.7 m diameter dish. As this satellite orbits the Earth, the area over which a signal can be received moves. There is a maximum time for which a signal can be picked up by a receiving station on Earth.

0 6

. 1

Describe **two** essential features of the orbit needed for the satellite to appear geostationary.

[2 marks]

Equatorial orbit, moving west to east.

Orbital period of 24 hours.

0 6

. 2

Calculate the time taken, in s, for the satellite mentioned in line 7 in the passage to complete one orbit around the Earth.

[1 mark]

$$T = 2\pi / \omega = 2\pi / 2.5 \times 10^{-4} = 2.5 \times 10^4 \text{ s}$$

time taken = 2.5×10^4 s

0 6

. 3

Show that at a distance of 12 000 km from the satellite the beam has a width of 1900 km.

[3 marks]

$$\lambda = c / f = 3.0 \times 10^8 / 1100 \times 10^6 = 0.273 \text{ m}$$

$$\theta = \lambda / d = 0.273 / 1.7 = 0.16 \text{ rad}$$

$$\text{width} = \text{distance} \times \theta = 12\,000 \text{ km} \times 0.16 = 1.9 \times 10^3 \text{ km}$$

(1925 km, which is about 1900 km)

0 6

. 4

The satellite is in a polar orbit and passes directly over a stationary receiver at the South Pole.

Show that the receiver can remain in contact with the satellite for no more than about 20 minutes each orbit.

radius of the Earth = 6400 km

[3 marks]

$$\text{angle subtended at Earth's centre} = \text{beam width} / \text{Earth's radius}$$

$$= 1.9 \times 10^3 \text{ km} / 6400 \text{ km} = 0.30 \text{ rad}$$

$$\text{time} = \text{angle} / \omega = 0.30 / 2.5 \times 10^{-4} = 1.2 \times 10^3 \text{ s}$$

$$= 1.19 \times 10^3 \text{ s} / 60 = 20 \text{ minutes}$$

maximum time = 20 minute

Turn over ►

0 6 . 5 The same satellite is moved into a higher orbit.

Discuss, with reasons, how this affects the signal strength and contact time for the receiver at the South Pole.

[4 marks]

The signal would be weaker at the receiver, as the distance it travels is greater.

The beam's energy is spread over a wider area, so the intensity decreases with increasing distance.

The signal is received for longer on each orbit: the beam width at the surface increases with the satellite's height, and the satellite moves at a lower angular speed in a higher orbit.

END OF SECTION A

Section B

Each of Questions 7 to 31 is followed by four responses, **A**, **B**, **C**, and **D**. For each question select the best response.

Only **one** answer per question is allowed.

For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD



WRONG METHODS



If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

0 7

Which of the following gives a correct unit for $\left(\frac{g^2}{G}\right)$?

[1 mark]

- A** N ☐
- B** N kg⁻¹ ☐
- C** N m ☐
- D** N m⁻² ☒

0 8

A planet has a radius half the Earth's radius and a mass a quarter of the Earth's mass. What is the approximate gravitational field strength on the surface of the planet?

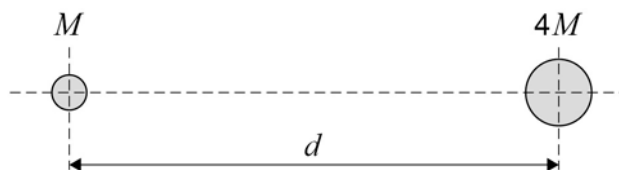
[1 mark]

- A** 1.6 N kg⁻¹ ☐
- B** 5.0 N kg⁻¹ ☐
- C** 10 N kg⁻¹ ☒
- D** 20 N kg⁻¹ ☐

Turn over ►

0 9

Two stars of mass M and $4M$ are at a distance d between their centres.



The resultant gravitational field strength is zero along the line between their centres at a distance y from the centre of the star of mass M .

What is the value of the ratio $\frac{y}{d}$?

[1 mark]

A $\frac{1}{2}$ ☐

B $\frac{1}{3}$ ☒

C $\frac{2}{3}$ ☐

D $\frac{3}{4}$ ☐

1 0

Which of the following statements about Newton's law of gravitation is correct?

Newton's gravitational law explains

[1 mark]

A the origin of gravitational forces. ☐

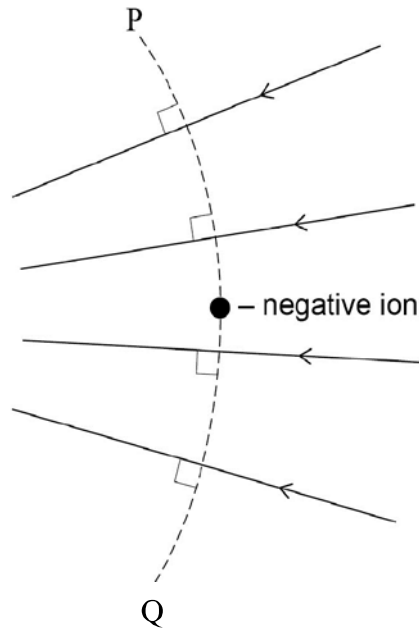
B why a falling satellite burns up when it enters the Earth's atmosphere.

C why projectiles maintain a uniform horizontal speed.

D how various factors affect the gravitational force between two particles. ☒

1 1

The diagram shows a small negative charge at a point in an electric field, which is represented by the arrowed field lines.



Which of the following statements, about what happens when the charge is displaced, is correct?

[1 mark]

When the negative charge is displaced

- A** to the left the magnitude of the electric force on it decreases.
- B** to the right its potential energy increases. ☐
- C** along the line PQ towards Q its potential energy decreases.
- D** along the line PQ towards P the magnitude of the electric force on it is unchanged. ☒

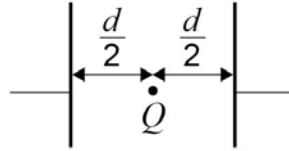
Turn over for the next question

Turn over ►

1 2

Two parallel metal plates are separated by a distance d and have a potential difference V across them. Which expression gives the magnitude of the electrostatic force acting on a charge Q placed midway between the plates?

[1 mark]



A $\frac{2VQ}{d}$ ☐

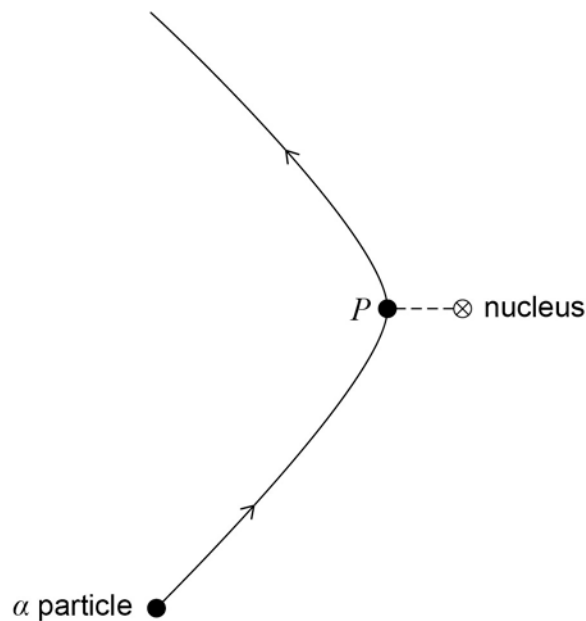
B $\frac{VQ}{d}$ ☒

C $\frac{VQ}{2d}$ ☐

D $\frac{Qd}{V}$ ☐

1 3

The diagram shows the path of an α particle deflected by the nucleus of an atom. Point P on the path is the point of closest approach of the α particle to the nucleus.



Which of the following statements about the α particle on this path is correct?

[1 mark]

A Its acceleration is zero at P. ☐

B Its kinetic energy is greatest at P. ☐

C Its potential energy is least at P. ☐

D Its speed is least at P. ☒

1 4

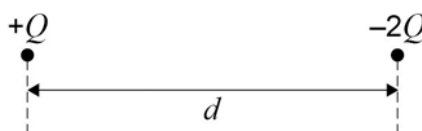
The electric potential at a distance r from a positive point charge is 45 V. The potential increases to 50 V when the distance from the point charge decreases by 1.5 m. What is the value of r ?

[1 mark]

- | | | |
|----------|-------|----------------------------------|
| A | 1.3 m | ☐ |
| B | 1.5 m | ☐ |
| C | 7.9 m | ☐ |
| D | 15 m | ☒ |

1 5

The diagram shows two particles at distance d apart. One particle has charge $+Q$ and the other $-2Q$. The two particles exert an electrostatic force of attraction, F , on each other. Each particle is then given an additional charge $+Q$ and their separation is increased to distance $2d$.



Which of the following gives the force that now acts between the two particles?

[1 mark]

- | | | | |
|----------|------------------------|---------------|----------------------------------|
| A | an attractive force of | $\frac{F}{4}$ | ☒ |
| B | a repulsive force of | $\frac{F}{4}$ | ☐ |
| C | an attractive force of | $\frac{F}{2}$ | ☐ |
| D | a repulsive force of | $\frac{F}{2}$ | ☐ |

1 6

Which of the following statements about a parallel plate capacitor is **incorrect**?

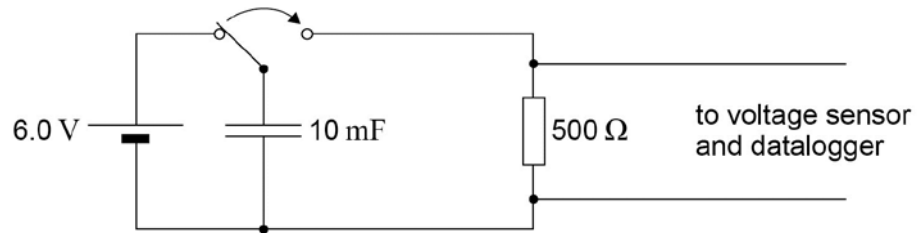
[1 mark]

- | | | |
|----------|--|----------------------------------|
| A | The capacitance of the capacitor is the amount of charge stored by the capacitor when the pd across the plates is 1 V. | ☐ |
| B | A uniform electric field exists between the plates of the capacitor. | ☐ |
| C | The charge stored on the capacitor is inversely proportional to the pd across the plates. | ☒ |
| D | The energy stored when the capacitor is fully charged is proportional to the square of the pd across the plates. | ☐ |

Turn over ►

1 7

A voltage sensor and a datalogger are used to record the discharge of a 10 mF capacitor in series with a 500 Ω resistor from an initial pd of 6.0 V. The datalogger is capable of recording 1000 readings in 10 s.



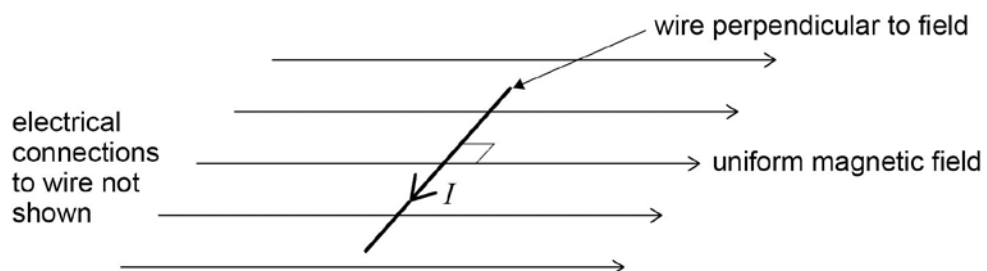
After a time equal to the time constant of the discharge circuit, which one of the rows gives the pd and the number of readings made?

[1 mark]

	Potential difference / V	Number of readings	
A	2.2	50	☐
B	3.8	50	☐
C	3.8	500	☐
D	2.2	500	☒

1 8

A horizontal straight wire of length 0.30 m carries a current of 2.0 A perpendicular to a horizontal uniform magnetic field of flux density 5.0×10^{-2} T. The wire 'floats' in equilibrium in the field.



What is the mass of the wire?

[1 mark]

- A 8.0×10^{-4} kg ☐
 B 3.1×10^{-3} kg ☒
 C 3.0×10^{-2} kg ☐
 D 8.2×10^{-1} kg ☐

1 9

Charged particles, each of mass m and charge Q , travel at a constant speed in a circle of radius r in a uniform magnetic field of flux density B .

Which expression gives the frequency of rotation of a particle in the beam?

[1 mark]

A $\frac{BQ}{2\pi m}$ 

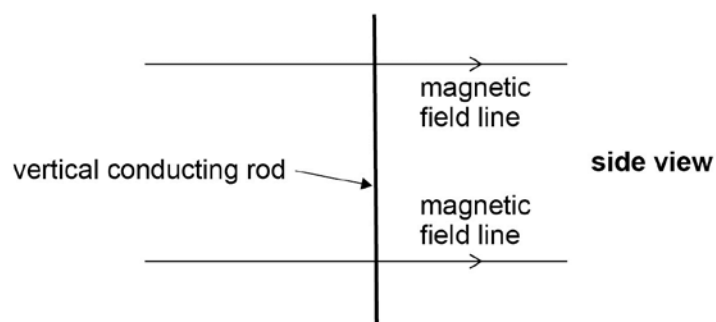
B $\frac{BQ}{m}$ 

C $\frac{BQ}{\pi m}$ 

D $\frac{2\pi BQ}{m}$ 

2 0

A vertical conducting rod of length l is moved at a constant velocity v through a uniform horizontal magnetic field of flux density B .



Which of the rows gives a correct expression for the induced emf between the ends of the rod for the stated direction of the motion of the rod?

[1 mark]

	Direction of motion	Induced emf	
A	Vertical	$\frac{B}{lv}$	
B	Horizontal at right angles to the field	Blv	
C	Vertical	Blv	
D	Horizontal at right angles to the field	$\frac{B}{lv}$	

Turn over ►

2 1

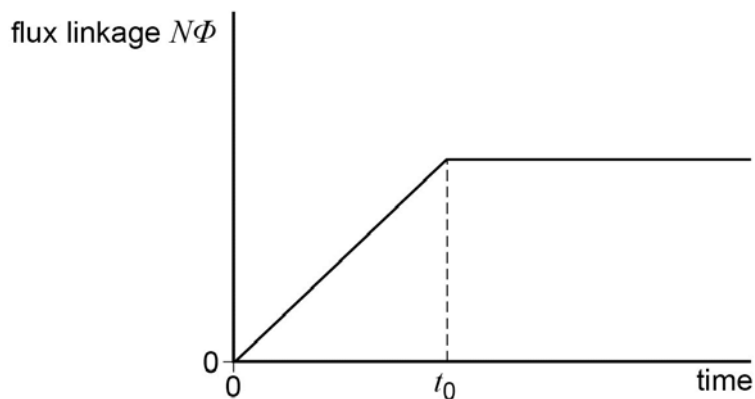
A simple pendulum and a mass-spring system have the same oscillation frequency f at the surface of the Earth. The pendulum and the mass-spring system are taken down a mine where the acceleration due to gravity is less than at the surface. What is the change in the frequency of the simple pendulum and the change in the frequency of the mass-spring system?

[1 mark]

	simple pendulum	mass-spring	
A	f increases	f decreases	☐
B	f decreases	f decreases	☐
C	f increases	f stays unchanged	☐
D	f decreases	f stays unchanged	☒

2 2

The graph shows how the flux linkage, $N\Phi$, through a coil changes when the coil is moved into a magnetic field.



The emf induced in the coil

[1 mark]

- A decreases then becomes zero after time t_0 .
 B increases then becomes constant after time t_0 .
 C is constant then becomes zero after time t_0 .
 D is zero then increases after time t_0 .

☐
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2	3
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A liquid flows continuously through a chamber that contains an electric heater. When the steady state is reached, the liquid leaving the chamber is at a higher temperature than the liquid entering the chamber. The difference in temperature is Δt .

Which of the following will increase Δt with no other change?

[1 mark]

- A Increasing the volume flow rate of the liquid
- B Changing the liquid to one with a lower specific heat capacity
- C Using a heating element with a higher resistance
- D Changing the liquid to one that has a higher density

☐
☒
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☐

Turn over for the next question

Turn over ►

2 4

The temperature of a hot liquid in a container falls at a rate of 2 K per minute just before it begins to solidify. The temperature then remains steady for 20 minutes by which time all the liquid has all solidified.

What is the quantity $\frac{\text{Specific heat capacity of the liquid}}{\text{Specific latent heat of fusion}}$?

[1 mark]

A $\frac{1}{40} \text{ K}^{-1}$ ☒

B $\frac{1}{10} \text{ K}^{-1}$ ☐

C 10 K^{-1} ☐

D 40 K^{-1} ☐

2 5

A fixed mass of gas occupies a volume V . The temperature of the gas increases so that the root mean square velocity of the gas molecules is doubled. What will the new volume be if the pressure remains constant?

[1 mark]

A $\frac{V}{2}$ ☐

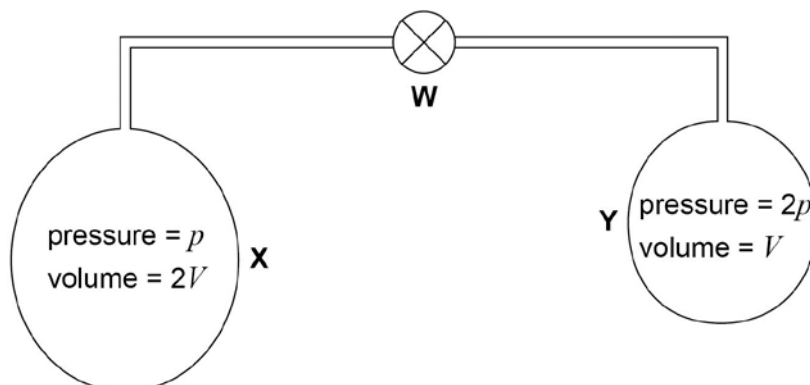
B $\frac{V}{\sqrt{2}}$ ☐

C $2V$ ☐

D $4V$ ☒

2 6

X and **Y** are two gas bottles that are connected by a tube that has negligible volume compared with the volume of each bottle.



Initially the valve **W** is closed.

X has a volume $2V$ and contains hydrogen at a pressure of p .

Y has a volume V and contains hydrogen at a pressure of $2p$.

X and **Y** are both initially at the same temperature.

W is now opened. Assuming that there is no change in temperature, what is the new gas pressure?

[1 mark]

- A** $\frac{2}{3}p$ ☐
- B** $\frac{5}{3}p$ ☐
- C** $\frac{4}{3}p$ ☒
- D** $\frac{3}{2}p$ ☐

2 7

A radioactive nucleus emits a β^- particle then an α particle and finally another β^- particle. The final nuclide is

[1 mark]

- A** an isotope of the original element ☒
- B** the same element with a different proton number ☐
- C** a new element of higher proton number ☐
- D** a new element of lower nucleon number ☐

Turn over ►

2 8

Which of the following best describes the decay constant for a radioisotope?

[1 mark]

- A** The reciprocal of the half-life of the radioisotope. ☐
- B** The rate of decay of the radioisotope. ☐
- C** The constant of proportionality which links half-life to the rate of decay of nuclei. ☐
- D** The constant of proportionality which links rate of decay to the number of undecayed nuclei. ☒

2 9

Which of the following is equal to $\frac{\text{radius of a nucleus of } {}^{125}_{51}\text{Sb}}{\text{radius of a nucleus of } {}^{64}_{30}\text{Zn}}$?

[1 mark]

- A** 1.19 ☐
- B** 1.25 ☒
- C** 1.33 ☐
- D** 1.40 ☐

3 0

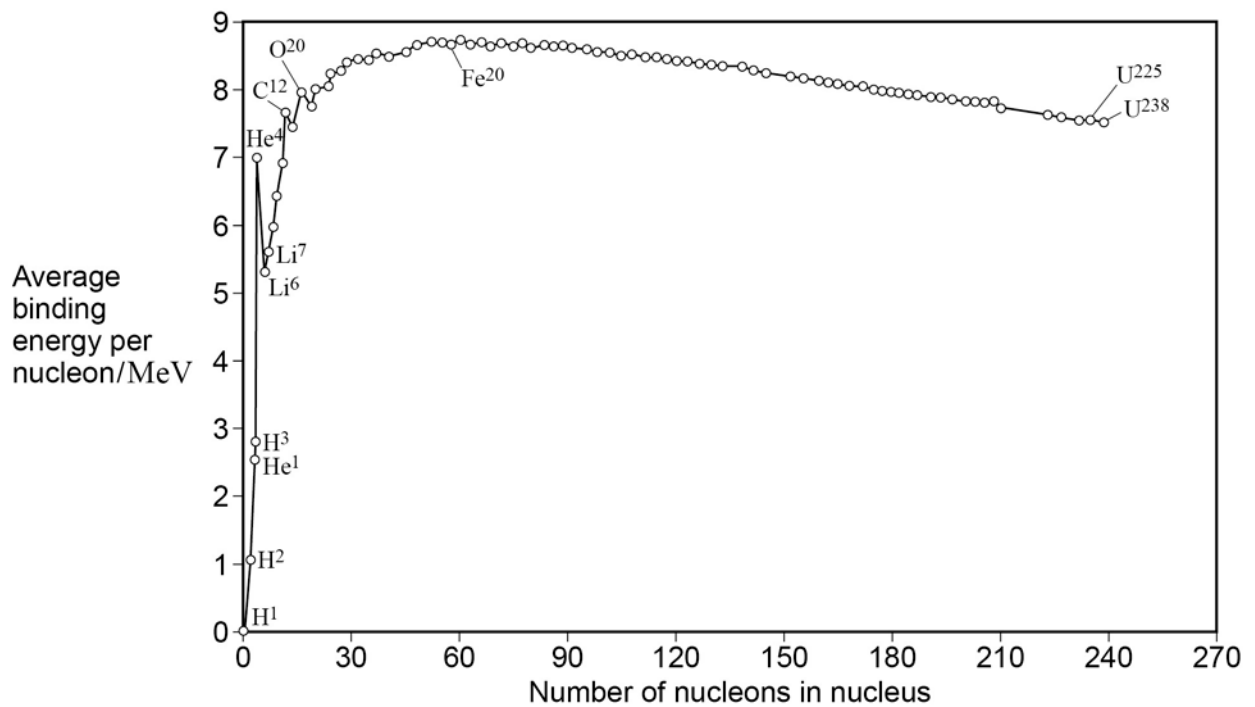
After 64 days the activity of a radioactive nuclide has fallen to one sixteenth of its original value. The half-life of the radioactive nuclide is

[1 mark]

- A** 2 days. ☐
- B** 4 days. ☐
- C** 8 days. ☐
- D** 16 days. ☒

3 1

The graph shows how the binding energy per nucleon varies with the nucleon number for stable nuclei.



What is the approximate total binding energy for a nucleus of ${}^{184}_{74}\text{W}$?

[1 mark]

- A** 1.28 pJ ☐
- B** 94.7 pJ ☐
- C** 103 pJ ☐
- D** 230 pJ ☒

END OF QUESTIONS

Turn over ►

There are no questions printed on this page.