

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

StemUp Model Solution

Forename(s)

Candidate signature

I declare this is my own work.

A-level PHYSICS

Paper 1

Time allowed: 2 hours

Materials

For this paper you must have:

- a pencil and a ruler
- a scientific calculator
- a Data and Formulae Booklet
- a protractor.

Instructions

- Use **black ink** or **black ball-point pen**.
- **Fill** in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do **all** rough work in this book. Cross through any work you do not want to be marked.
- Show **all** your working.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 85.
- You are expected to use a scientific calculator where appropriate.
- A Data and Formulae Booklet is provided as a loose insert.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7–31	
TOTAL	



Section A

Answer **all** questions in this section.

0 1

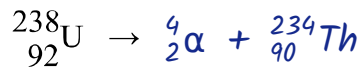
Two stable isotopes of helium are ${}^4_2\text{He}$ and ${}^3_2\text{He}$.

0 1 . 1

An atom of ${}^4_2\text{He}$ is produced in a rock that contains uranium. It is produced following the radioactive decay of a ${}^{238}_{92}\text{U}$ atom. The decay also creates an atom of thorium (Th).

Write an equation for the decay of ${}^{238}_{92}\text{U}$.

[2 marks]



0 1 . 2

A ${}^3_2\text{He}$ nucleus can be produced by the decay of a tritium nucleus ${}^3_1\text{H}$.

State and explain which exchange particle is responsible for this decay.

[2 marks]

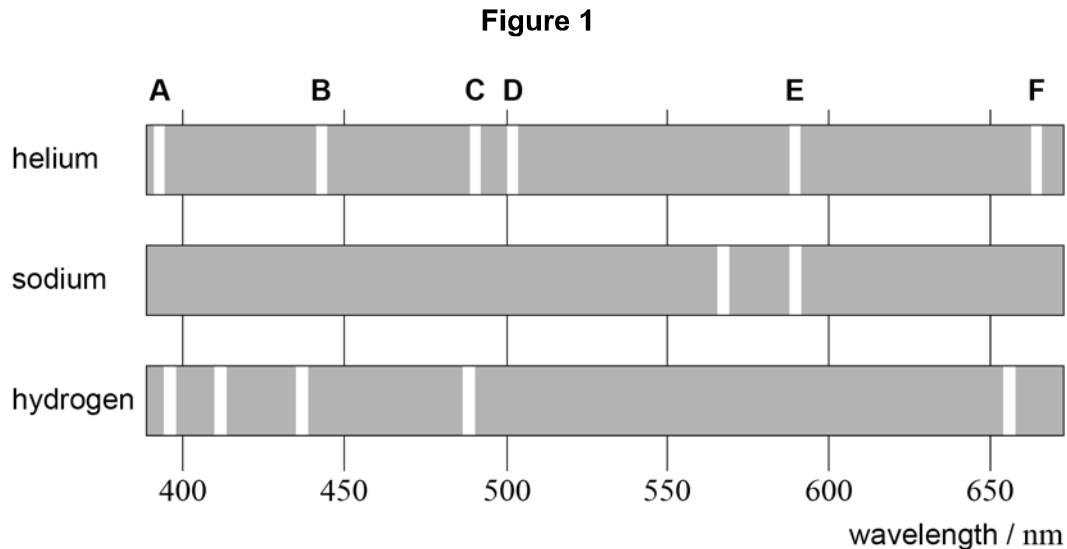
The exchange particle is the W^- boson. The decay is β^- decay, so it is a weak interaction; a neutron in the tritium nucleus changes into a proton (a down quark changes to an up quark).

The W^- must be negative so that charge is conserved: $n \rightarrow p + W^-$, then $W^- \rightarrow e^- + \text{antineutrino}$.



Helium was discovered by analysing the light in the **absorption** spectrum of the Sun.

Figure 1 shows the positions of the brightest lines, labelled **A** to **F**, in the **emission** spectrum of helium. The brightest lines in the emission spectra of sodium and hydrogen are also shown.



0 1 . 3

Before helium was identified, some scientists suggested that the lines of the helium spectrum seen in the absorption spectrum of the Sun were due to the presence of sodium and hydrogen.

Discuss, with reference to the lines **A** to **F** in **Figure 1**, the evidence for and against this suggestion.

[2 marks]

For: line C is present in the hydrogen spectrum (and in the helium spectrum), and line E is present in the sodium spectrum (and in the helium spectrum), so these lines could be explained by sodium and hydrogen.

Against: line D (about 500 nm) is in neither the hydrogen nor the sodium spectrum, so it cannot be due to sodium or hydrogen and there must be another element (helium) present.

Question 1 continues on the next page

Turn over ►



0 1 . 4

Calculate, in eV, the change in energy level responsible for the spectral line labelled E in Figure 1.

[3 marks]

From Figure 1, wavelength of line E = 587 nm

$$E = hc / \lambda = (6.63 \times 10^{-34} \times 3.00 \times 10^8) / (587 \times 10^{-9})$$

$$E = 3.39 \times 10^{-19} \text{ J}$$

$$\text{in eV: } E = 3.39 \times 10^{-19} / 1.60 \times 10^{-19}$$

$$E = 2.12 \text{ eV}$$

change in energy level = 2.12 eV

0 1 . 5

Explain, with reference to the processes within an atom, the difference between an emission spectrum and an absorption spectrum.

[3 marks]

A photon is a carrier of energy, and an atom can only absorb or emit a photon whose energy hf exactly equals the difference between two of its energy levels.

Absorption spectrum: white light passes through cool gas; electrons in the atoms absorb photons of particular energies and become excited, moving up to a higher energy level. These wavelengths are removed, giving dark lines on a continuous spectrum.

Emission spectrum: excited atoms de-excite, with electrons moving down to a lower energy level and emitting a photon of energy equal to the energy difference. Only these wavelengths are seen, as bright lines on a dark background.



0 2

Carbon-14 decays into nitrogen-14 with the release of a beta (β^-) particle and an antineutrino ($\bar{\nu}_e$).

0 2 . 1

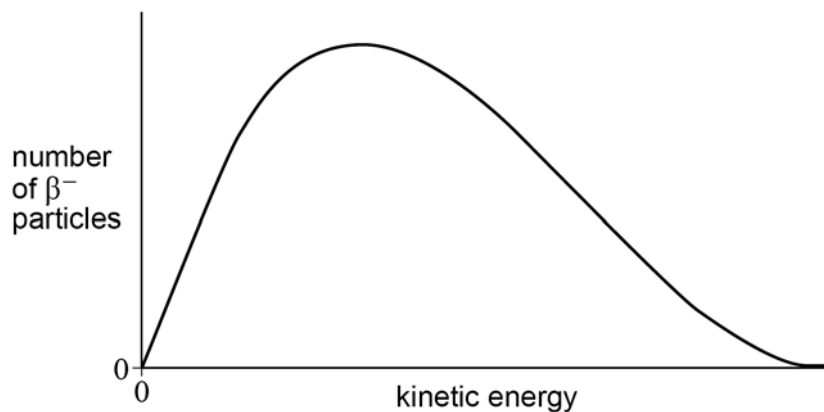
State the change of quark character in β^- decay.

[1 mark]

A down quark changes into an up quark ($d \rightarrow u$).

0 2 . 2

Figure 2 shows the distribution of kinetic energies of β^- particles from the decay of carbon-14.

Figure 2

Explain how **Figure 2** supports the existence of the antineutrino.

[2 marks]

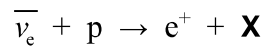
The β^- particles have a range (continuous spread) of kinetic energies, from zero up to a maximum.

But each decay releases a fixed total amount of energy, so another particle (the antineutrino) must be emitted that carries away the rest of the energy in each decay, so that energy is conserved.

Question 2 continues on the next page

Turn over ►

The existence of the antineutrino was confirmed by experiments in which antineutrinos interact with protons. The equation for this interaction is:



0 2 . 3

Identify particle **X**.

[1 mark]

neutron

0 2 . 4

The positron released in this interaction is annihilated when it encounters an electron. A pair of gamma photons is then produced. Particle **X** can be absorbed by a nucleus. This produces another gamma ray. **Table 1** contains data for three gamma photons detected during an antineutrino–proton interaction experiment.

Table 1

Gamma photon	Photon energy / J
G1	5.0×10^{-14}
G2	6.6×10^{-14}
G3	1.0×10^{-13}

Deduce which of the three gamma photons could have been produced by positron annihilation.

[3 marks]

Minimum energy released when a positron and electron annihilate

(at rest) = 2 × rest energy = 2 × 0.511 MeV = 1.022 MeV

= 1.022 × 10⁶ × 1.60 × 10⁻¹⁹ = 1.64 × 10⁻¹³ J

Two photons are produced, so each photon has energy of at least

1.64 × 10⁻¹³ / 2 = 8.2 × 10⁻¹⁴ J

G1 (5.0 × 10⁻¹⁴ J) and G2 (6.6 × 10⁻¹⁴ J) < 8.2 × 10⁻¹⁴ J

Only G3 (1.0 × 10⁻¹³ J > 8.2 × 10⁻¹⁴ J) has enough energy to have been made in the annihilation, so G3.



Turn over for the next question

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ANSWER IN THE SPACES PROVIDED**

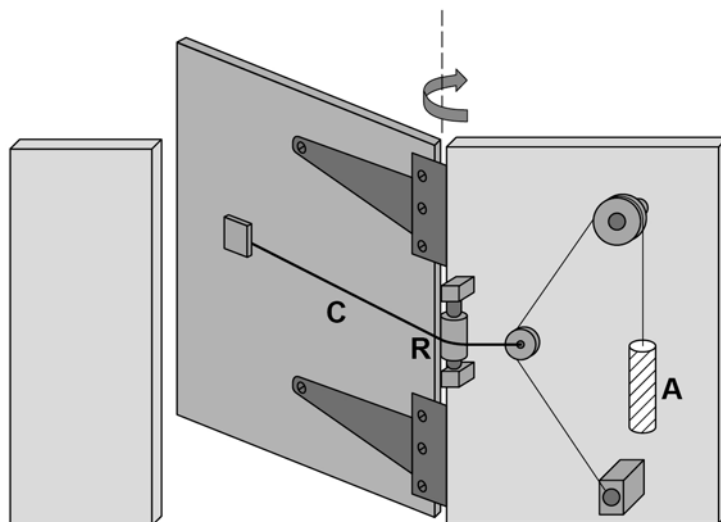
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0 3

Figure 3 shows a garden gate with a pulley system designed to close the gate.

Figure 3



The pulley system raises weight **A** when the gate is opened. When the gate is released, **A** falls. The horizontal cable **C** passes over pulley **R**. The tension in cable **C** causes the gate to close.

Weight **A** is a solid cylinder with the following properties:

$$\text{diameter} = 4.8 \times 10^{-2} \text{ m}$$

$$\text{length} = 0.23 \text{ m}$$

$$\text{weight} = 35 \text{ N}$$

Table 2 gives the density of three available materials.

Table 2

Material	Density / kg m^{-3}
concrete	2.4×10^3
iron	7.8×10^3
brass	8.6×10^3



0 3 . 1

Deduce which **one** of the three materials is used for **A**.**[3 marks]**

$$\text{Volume of A} = \pi r^2 \times \text{length} = \pi \times (2.4 \times 10^{-2})^2 \times 0.23$$

$$V = 4.16 \times 10^{-4} \text{ m}^3$$

$$\text{Mass of A} = W / g = 35 / 9.81 = 3.57 \text{ kg}$$

$$\text{Density} = \text{mass} / \text{volume} = 3.57 / 4.16 \times 10^{-4}$$

$$\rho = 8.6 \times 10^3 \text{ kg m}^{-3}$$

$$(\text{check: mass if brass} = 8.6 \times 10^3 \times 4.16 \times 10^{-4} = 3.58 \text{ kg},$$

$$\text{weight} = 3.58 \times 9.81 = 35 \text{ N, which is the weight of A})$$

The density of A matches the density of brass ($8.6 \times 10^3 \text{ kg m}^{-3}$), so

A is made of brass.

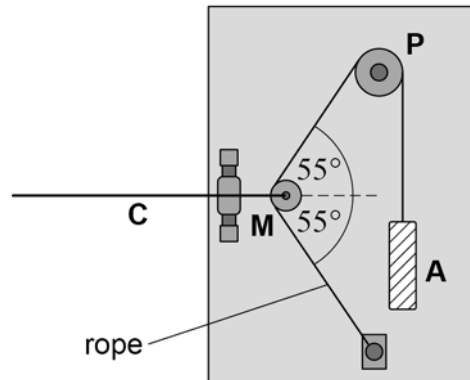
Question 3 continues on the next page

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Figure 4 shows the pulley arrangement when the gate is closed.

Figure 4



Pulleys **P** and **M** are frictionless so that the tension in the rope attached to **A** is equal to the weight of **A**.

A weighs 35 N and the weight of moveable pulley **M** is negligible.

0 3 . 2

Calculate the tension in the horizontal cable **C** when the gate is closed.

[2 marks]

$$\text{Rope tension on each side of M} = \text{weight of A} = 35 \text{ N}$$

$$\text{Horizontal component of each} = 35 \cos 55^\circ = 20.1 \text{ N}$$

$$T = 2 \times 35 \cos 55^\circ = 40.2 \text{ N}$$

$$\text{tension} = \underline{\quad 40 \quad} \text{ N}$$

0 3 . 3

Pulley **M** is pulled to the left as the gate is opened.

Explain why this increases the tension in the horizontal cable **C**.

[2 marks]

As **M** moves left, the angle between each part of the rope and the horizontal decreases, while the tension in the rope stays equal to the weight of **A** (35 N).

So the horizontal components of the rope tension ($35 \cos \theta$) increase, and the tension in cable **C**, which balances them, must increase.



Question 3 continues on the next page

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ANSWER IN THE SPACES PROVIDED**

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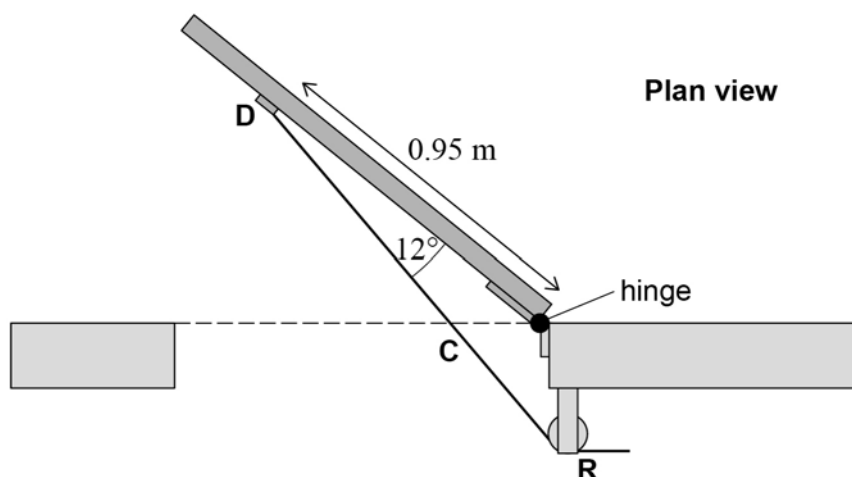


0 3 . 4

Figure 5 shows a plan view with the gate open. The horizontal cable **C** passes over pulley **R** and is attached to the door at **D**. The angle between the door and the horizontal cable **C** is 12° .

The horizontal distance between the hinge and **D** is 0.95 m.

Figure 5



The tension in the horizontal cable **C** is now 41 N.

Calculate the moment of the tension about the hinge.

[2 marks]

Component of tension perpendicular to the door:

$$F_{\perp} = 41 \sin 12^\circ = 41 \cos (90^\circ - 12^\circ) = 8.5 \text{ N}$$

$$\text{Moment} = F_{\perp} \times \text{distance} = 8.5 \times 0.95$$

$$\text{Moment} = 8.1 \text{ N m}$$

moment = 8.1 N m



0 3 . 5

The same system is attached to an identical gate with stiffer hinges. Now the system does not supply a sufficiently large moment to close the gate.

Discuss **two** independent changes to the design to increase the moment about the hinges due to horizontal cable **C**.

[4 marks]

1 *Increase the weight of A (use a denser material or a larger volume, e.g. a longer cylinder). This increases the tension in the rope and so increases the tension in C, and therefore the moment about the hinges.*

2 *Move D further from the hinge (attach the cable C further along the door). This increases the perpendicular distance from the hinge to the line of the force, and therefore increases the moment.*

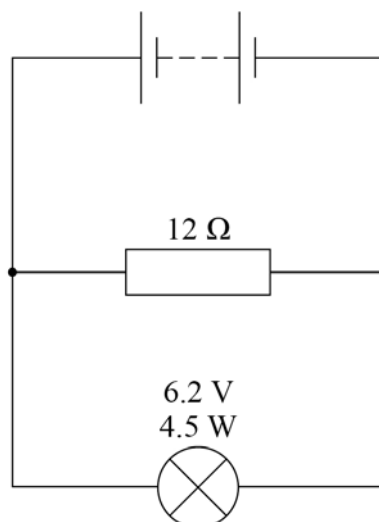
13

Turn over for the next question

Turn over ►



0 4

A student assembles the circuit in **Figure 6**.**Figure 6**The battery has an internal resistance of 2.5Ω .

0 4 . 1

Show that the resistance of the 6.2 V , 4.5 W lamp at its working potential difference (pd) is about 9Ω .**[1 mark]**

$$R = V^2 / P = 6.2^2 / 4.5 = 8.5 \Omega \ (\approx 9 \Omega)$$

0 4 . 2

The terminal pd across the battery is 6.2 V .

Calculate the emf of the battery.

[3 marks]

$$\text{Current in lamp} = V / R = 6.2 / 8.54 = 0.73 \text{ A}$$

$$\text{Current in } 12 \Omega \text{ resistor} = 6.2 / 12 = 0.52 \text{ A}$$

$$\text{Total current } I = 0.73 + 0.52 = 1.24 \text{ A}$$

$$\text{emf} = \text{terminal pd} + Ir$$

$$\varepsilon = 6.2 + (1.24 \times 2.5)$$

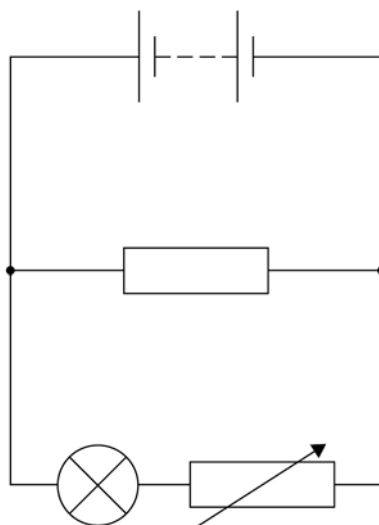
$$\varepsilon = 9.3 \text{ V}$$

$$\text{emf} = \underline{\quad 9.3 \quad} \text{ V}$$



The student makes a variable resistor to control the brightness of the lamp.
Figure 7 shows her circuit.

Figure 7



0 4 . 3

She uses a resistance wire with a diameter of 0.19 mm to make the variable resistor.
A 5.0 m length of this wire has a resistance of 9.0 Ω .

Calculate the resistivity of the wire.

[3 marks]

$$A = \pi(d / 2)^2 = \pi \times (0.19 \times 10^{-3} / 2)^2$$

$$A = 2.84 \times 10^{-8} \text{ m}^2$$

$$\rho = RA / l = (9.0 \times 2.84 \times 10^{-8}) / 5.0$$

$$\rho = 5.1 \times 10^{-8} \Omega \text{ m}$$

resistivity = 5.1 $\times 10^{-8}$ $\Omega \text{ m}$

Question 4 continues on the next page

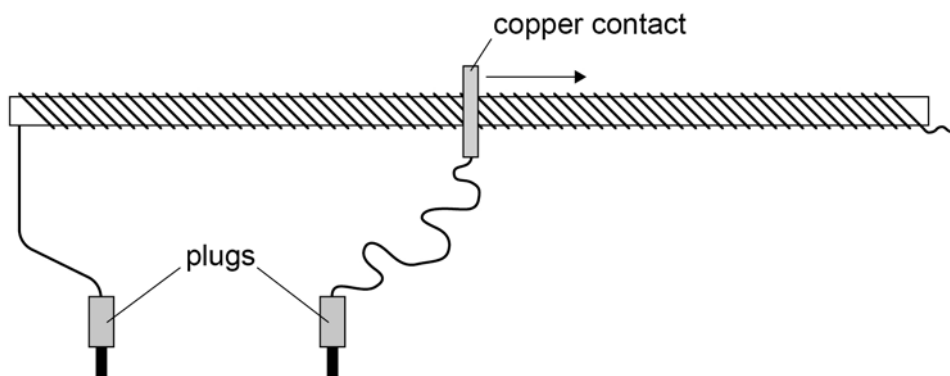
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0 4 . 4

Figure 8 shows the 5.0 m length of wire wrapped around a tube to make the variable resistor.

Figure 8



Two plugs connect the variable resistor into the circuit. A moveable copper contact is used to vary the length of wire in series with the lamp.

When the contact is placed on the tube at one particular position, the lamp is dim. The contact is then moved slowly to the right as shown in **Figure 8**.

Explain, without calculation, what happens to the brightness of the lamp as the contact is moved.

[2 marks]

Moving the contact to the right increases the length of wire in series with the lamp, so the resistance increases.

This reduces the current through the lamp, so the lamp becomes dimmer.



0 4 . 5

The student now makes a different circuit by connecting the variable resistor **in parallel** with the lamp.

The contact is returned to its original position on the tube as shown in **Figure 8** and the lamp is dim. The contact is again slowly moved to the right.

Explain, without calculation, what happens to the brightness of the lamp as the contact is moved.

[2 marks]

Moving the contact to the right increases the resistance of the parallel section, so the total (external) circuit resistance increases and the current from the battery decreases.

So the pd dropped across the internal resistance (lost volts) decreases, the terminal pd across the lamp increases, and the lamp becomes brighter.

11

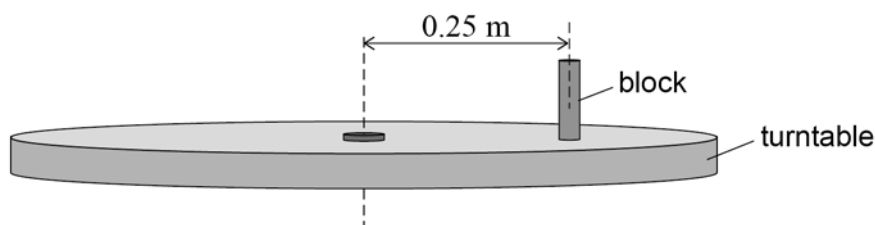
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0 5

A teacher sets up a demonstration to show the relationship between circular motion and simple harmonic motion (SHM). She places a block on a turntable at a point 0.25 m from its centre, as shown in **Figure 9**.

Figure 9

The turntable rotates with an angular speed of 1.8 rad s^{-1} and the block does not slip.

0 5

. 1

Calculate the time taken for the turntable to complete one revolution.

[2 marks]

$$\text{time} = \text{angle} / \text{angular speed} = 2\pi / \omega$$

$$T = 2\pi / 1.8$$

$$T = 3.5 \text{ s}$$

$$\text{time} = \underline{\quad 3.5 \quad} \text{ s}$$



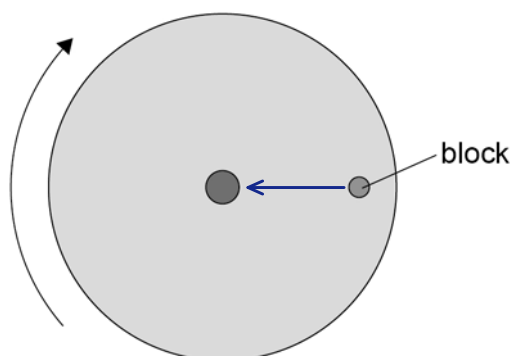
0 5 . 2

Figure 10 shows a plan view of the turntable and block.
The turntable rotates in a clockwise direction.

Draw an arrow on **Figure 10** to show the direction of the resultant force on the block.

[1 mark]

Figure 10



0 5 . 3

The mass of the block is 0.12 kg.

Calculate the magnitude of the resultant force on the block.

[2 marks]

$$F = mr\omega^2 = 0.12 \times 0.25 \times 1.8^2$$

$$F = 0.097 \text{ N}$$

magnitude of force = 0.097 N

Question 5 continues on the next page

Turn over ►



0 5 . 4

Describe, with reference to one of Newton's laws of motion, the evidence that a resultant force is acting on the block.

[2 marks]

The block is constantly changing direction (moving in a circle at constant speed), so its velocity is changing.

By Newton's first law, a resultant force must act, since otherwise the block would move in a straight line at constant speed.

0 5 . 5

The teacher adjusts the angular speed of the turntable so that the block completes one rotation every 2.50 s.
She sets up a simple pendulum above the centre of the turntable so that it swings in phase with the movement of the block.

Calculate the length of the simple pendulum.

[2 marks]

$$T = 2\pi \sqrt{l/g} \quad \text{so} \quad l = gT^2 / 4\pi^2$$

$$l = 9.81 \times 2.50^2 / 4\pi^2$$

$$l = 1.55 \text{ m}$$

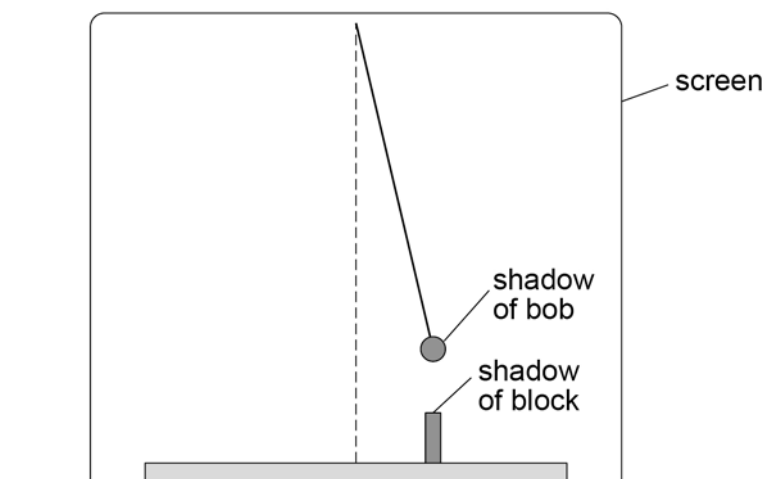
length = 1.55 m



0 5 . 6

A lamp is used to project shadow images of the block and pendulum bob on a screen. Both shadows appear to move with SHM across the screen. **Figure 11** shows the images on the screen at one instant.

Figure 11



Initially the shadows move in phase with the same amplitude.

Air resistance affects the motion of the pendulum.

Suggest the effect this has on the amplitude relationship and the phase relationship between the moving shadows.

[2 marks]

amplitude The amplitude of the pendulum shadow decreases, so it becomes less than the block shadow amplitude.

phase The pendulum's time period changes (decreases) as its amplitude gets less, so the shadows move out of phase.

11

Turn over ►

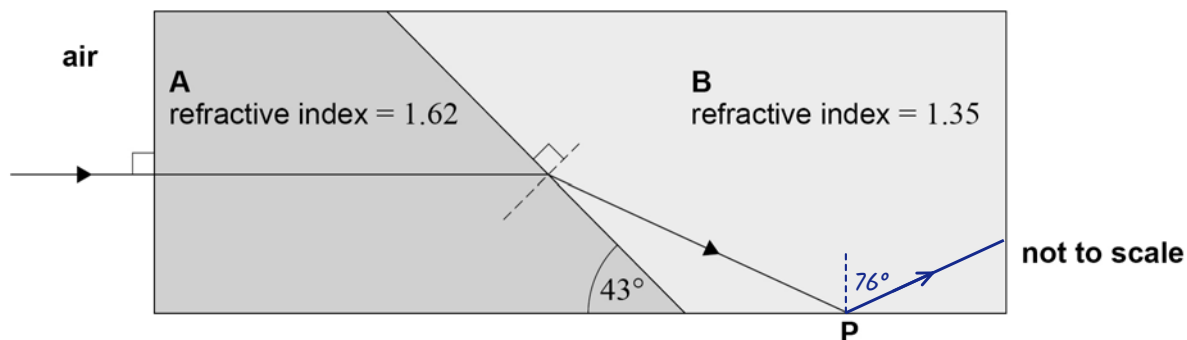


0 6

Two transparent prisms **A** and **B** of different refractive indices are placed in contact to produce a rectangular block.

Figure 12 shows the path of a ray, incident normally on **A**, refracting as it crosses the boundary between the prisms.

Figure 12



0 6 . 1

Explain how the path of the ray shows that the refractive index of **A** is greater than the refractive index of **B**.

[1 mark]

*The angle of refraction in B is greater than the angle of incidence in A:
the ray bends away from the normal, so it speeds up. By Snell's law $n_A \sin i = n_B \sin r$, so $n_A > n_B$.*



0 6 . 2

Show that the angle of refraction of the ray in **B** is about 60° .

[2 marks]

$$\text{Angle of incidence at the boundary} = 90^\circ - 43^\circ = 47^\circ$$

$$\text{Snell's law: } n_A \sin \theta_A = n_B \sin \theta_B$$

$$1.62 \times \sin 47^\circ = 1.35 \times \sin \theta_B$$

$$\sin \theta_B = 1.62 \times 0.731 / 1.35 = 0.878$$

$$\theta_B = 61.4^\circ \approx 60^\circ$$

0 6 . 3

Draw, on **Figure 12**, the path of the ray immediately after it reaches **P**. Justify your answer with calculations.

[3 marks]

$$\text{Critical angle for B to air: } \sin c = 1 / n = 1 / 1.35$$

$$c = 47.8^\circ \approx 48^\circ$$

$$\text{Angle of incidence at P: } i = 180^\circ - 43^\circ - 61.4^\circ = 76^\circ$$

$$i = 76^\circ > c = 48^\circ, \text{ so total internal reflection occurs at P:}$$

the ray reflects off P at 76° to the normal (drawn on Figure 12).

6

END OF SECTION A

Turn over ►



Section B

Each of Questions **07** 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 question, 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. 

You may do your working in the blank space around each question but this will not be marked.
Do **not** use additional sheets for this working.

07 Which two quantities have the base unit $\text{kg m}^2 \text{s}^{-2}$?

[1 mark]

A kinetic energy and momentum

☐

B kinetic energy and Young modulus

☐

C work done and the moment of a couple

☒

D work done and pressure

☐

08 Which gives SI prefixes in descending order of magnitude?

[1 mark]

A G p m

☐

B M G n

☐

C m n μ

☐

D m μ p

☒


0 9A car travels at 100 km h^{-1} on a motorway.

What is an estimate of its kinetic energy?

[1 mark]**A** 10^4 J ☐**B** 10^6 J ☒**C** 10^8 J ☐**D** 10^{10} J ☐**1 0**What is the specific charge of a ${}^{13}_6\text{C}$ nucleus?**[1 mark]****A** $4.4 \times 10^7 \text{ C kg}^{-1}$ ☒**B** $5.2 \times 10^7 \text{ C kg}^{-1}$ ☐**C** $8.3 \times 10^7 \text{ C kg}^{-1}$ ☐**D** $2.1 \times 10^8 \text{ C kg}^{-1}$ ☐**1 1**

Which row describes the variation with distance of the strong nuclear force?

[1 mark]

	Attractive	Repulsive
A	beyond 3 fm	from 0.5 fm to 3 fm
B	from 0.5 fm to 3 fm	beyond 3 fm
C	from 0.5 fm to 3 fm	up to 0.5 fm
D	up to 0.5 fm	from 0.5 fm to 3 fm

☐☐☒☐**Turn over ►**

1 2 Which statement is correct?

[1 mark]

- A** All strange particles are mesons. ☐
- B** Strange particles are always created in pairs. ☒
- C** Strangeness can only change in strong interactions. ☐
- D** Strangeness can only have a value of 0 or -1 ☐

1 3 Which combination of quarks is possible?

[1 mark]

- A** sd ☐
- B** sū ☒
- C** sūd ☐
- D** ud ☐

1 4 In photoelectricity, V_s is the stopping potential.

What quantity is eV_s ?

[1 mark]

- A** energy of an incident photon ☐
- B** maximum kinetic energy of a photoelectron ☒
- C** threshold frequency $\times$ the Planck constant ☐
- D** work function ☐



1 5 A fluorescent tube contains a gas.

The coating of the tube

[1 mark]

A becomes ionised by the gas and emits photons of ultraviolet light.

☐

B absorbs photons of ultraviolet light from the gas and emits visible light.

☒

C absorbs photons of ultraviolet light from the gas and emits photoelectrons.

☐

D absorbs several photons of visible light from the gas and then emits one photon of ultraviolet light.

☐

1 6 Which row gives evidence for the wave nature of electrons and evidence for the particulate nature of light?

[1 mark]

	Wave nature of electrons	Particulate nature of light
A	electron diffraction	photoelectric effect
B	electron diffraction	single-slit diffraction
C	photoelectric effect	single-slit diffraction
D	photoelectric effect	electron diffraction

☒
☐
☐
☐

1 7 Which particle has the smallest de Broglie wavelength?

[1 mark]

A an electron moving at $4 \times 10^3 \text{ m s}^{-1}$

☐

B a proton moving at $4 \times 10^3 \text{ m s}^{-1}$

☐

C an electron moving at $8 \times 10^5 \text{ m s}^{-1}$

☐

D a proton moving at $8 \times 10^5 \text{ m s}^{-1}$

☒

Turn over ►



1 8

A longitudinal wave of frequency 660 Hz travels through a medium.
The wave speed is 330 m s^{-1} .

Which statement describes the motion of a particle in the wave?

[1 mark]

A It is travelling at a speed of 330 m s^{-1} .

☐

B It moves in phase with a particle in the wave 25 cm away.

☐

C It oscillates with a time period of 1.5 ms.

☒

D It changes direction 660 times every second.

☐
1 9

The frequency of the first harmonic of a standing wave on a string is f .
The tension in the string is T .
The tension is increased to $4T$ without changing the length or mass of the string.

Which harmonic has a frequency $2f$ after this change?

[1 mark]

A first

☒

B second

☐

C third

☐

D fourth

☐
2 0

Light of wavelength $5.2 \times 10^{-7} \text{ m}$ is used in a Young's double-slit experiment.
The distance from the slits to the screen is 1.5 m.
The width of ten fringes is 3.5 cm.

What is the separation of the two slits?

[1 mark]

A $2.2 \times 10^{-5} \text{ m}$

☐

B $9.9 \times 10^{-5} \text{ m}$

☐

C $1.1 \times 10^{-4} \text{ m}$

☐

D $2.2 \times 10^{-4} \text{ m}$

☒

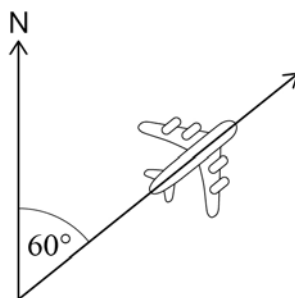

- 2 1** Monochromatic light of wavelength $5.8 \times 10^{-7} \text{ m}$ is incident normally on a plane transmission diffraction grating that has a slit separation of $2.5 \times 10^{-6} \text{ m}$.

How many maxima are produced by the grating?

[1 mark]

- A** 4 ☐
- B** 5 ☐
- C** 8 ☐
- D** 9 ☒

- 2 2** An aeroplane flies horizontally at 150 m s^{-1} along a bearing 60° east of north.



How far north from its starting position is the aeroplane after one hour?

[1 mark]

- A** 270 km ☒
- B** 470 km ☐
- C** 510 km ☐
- D** 540 km ☐

Turn over ►



2 3

A ball is thrown vertically upwards and returns to its original position 2.4 s later.
The effect of air resistance is negligible.

What is the total distance travelled by the ball?

[1 mark]**A** 5.9 m☐**B** 7.1 m☐**C** 14 m☒**D** 28 m☐**2 4**

A truck of mass 2.1×10^3 kg tows a car of mass 1.3×10^3 kg along a horizontal road.
The total resistive force on the car is 1100 N.
The acceleration of the car and truck is 2.3 m s^{-2} .

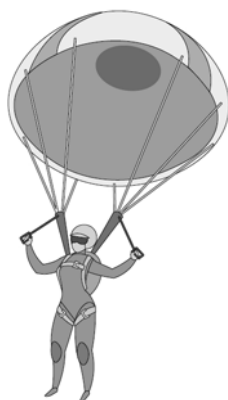


What is the tension in the tow rope?

[1 mark]**A** 3000 N☐**B** 4100 N☒**C** 7800 N☐**D** 8900 N☐

2 5

A parachutist descends to the ground at a constant speed with the parachute open.



Which force, together with the parachutist's weight, makes a pair according to Newton's third law of motion?

[1 mark]

- A** the drag force on the parachutist from the air
- B** the tension in the strings of the parachute
- C** the gravitational force of the parachutist on the Earth
- D** the lift force on the parachute from the air

☐
☐
☒
☐
2 6

A tennis ball has a mass of 58 g.
The ball is dropped from rest from a height of 1.8 m above the ground and falls vertically.
The ball rebounds vertically to a height of 1.1 m.
The effect of air resistance is negligible.

What is the change in momentum of the ball during its collision with the ground?

[1 mark]

- A** 0.040 N s

☐

- B** 0.075 N s

☐

- C** 0.215 N s

☐

- D** 0.614 N s

☒
Turn over ►

2 7

A mass M is suspended from a spring. When the mass is at rest at the equilibrium position, the elastic potential energy stored is E .
An extra mass of $2M$ is added to the spring and the spring extends while still obeying Hooke's law.

What is the total elastic energy stored when the system is at rest at the new equilibrium position?

[1 mark]

A $2E$ ☐

B $3E$ ☐

C $4E$ ☐

D $9E$ ☒

2 8

Two wires P and Q are made of the same material and have the same cross-sectional area.

P has an original length L and is subject to a tensile force F . P extends a distance x .

Q has an original length $2L$ and is subject to a tensile force $2F$.

Which statement is correct?

[1 mark]

A The stress in P and the stress in Q are the same. ☐

B The extension of Q is $2x$. ☐

C The strain of Q is double the strain of P. ☒

D The value of $\frac{\text{stress}}{\text{strain}}$ for P is half that of Q. ☐

2 9

The current in a metallic conductor is 1.5 mA.

How many electrons pass a point in the conductor in two minutes?

[1 mark]

A 1.1×10^{18} ☒

B 1.9×10^{19} ☐

C 1.4×10^{20} ☐

D 2.0×10^{29} ☐



3 0Which value of resistance **cannot** be made by combining three $10\ \Omega$ resistors?**[1 mark]****A** $3.3\ \Omega$ ☐**B** $6.7\ \Omega$ ☐**C** $15\ \Omega$ ☐**D** $25\ \Omega$ ☒**3 1**A particle performs simple harmonic motion with a time period of $1.4\ \text{s}$ and an amplitude of $12\ \text{mm}$.

What is the maximum speed of the particle?

[1 mark]**A** $8.6\ \text{mm s}^{-1}$ ☐**B** $27\ \text{mm s}^{-1}$ ☐**C** $54\ \text{mm s}^{-1}$ ☒**D** $110\ \text{mm s}^{-1}$ ☐**25****END OF QUESTIONS**

There are no questions printed on this page

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