OCR Physics B (Advancing Physics)

Multiple Choice Questions

Examiners Report

The question paper requested that candidates wrote their response to the question in the box provided. While the vast majority did follow this instruction, some circled the letter in the question. In the absence of any obvious contradiction, this will be credited however candidates are strongly encouraged to use the box to avoid any possible confusion. Most candidates show suitable working in the space at the side of the question, showing how they reached their answer although this is not required. However, it is noted that those who do this are more likely to reach the correct response. A significant number of candidates did not attempt one or more of the multiple-choice questions, although there is no penalty for incorrect responses. As there was no evidence of lack of time, it is assumed that the candidates were unaware of how to answer that question. It is important that any changes to the response are clearly identified; for the most part, when candidates changed their mind, they made this clear by fully crossing out the incorrect response and writing the new response next to it, often in a newly draw box. This is the recommended method. However, a few wrote over the original response, making it unclear which their final response was, which cannot be credited. Similarly, some candidates did not make the distinction between “B” and “D” clear enough.

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SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

1 Here is a list of combinations of base units of the SI system.

Which combination of units is equivalent to a newton, N?

A kg m s^{-1}

B kg m s^{-2}

C kg m^2 s^{-2}

D kg m^2 s^{-3}

Your answer ☐ **[1]**

2 Here is a list of combinations of base units of the SI system.

Which combination of units is equivalent to watt, W?

A kg m s^{-1}

B kg m s^{-2}

C kg m^2 s^{-2}

D kg m^2 s^{-3}

Your answer ☐ **[1]**

3 Which of these quantities would be measured in pascals?

A weight

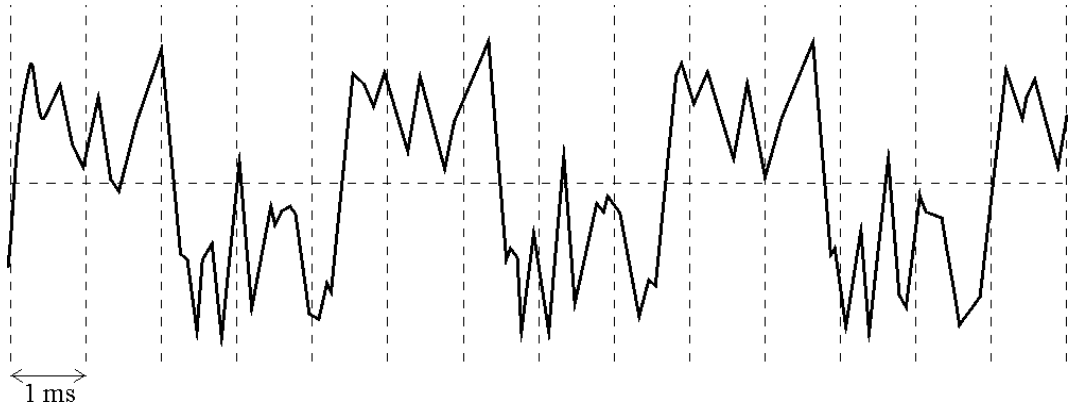
B strain

C stress

D tension

Your answer ☐ **[1]**

4 A musical note played by a clarinet is recorded. The signal is shown in the diagram with the time-scale indicated.



What is the fundamental frequency of the note played by the clarinet, expressed to two significant figures?

A 77 Hz

B 120 Hz

C 230 Hz

D 2200 Hz

Your answer ☐ **[1]**

5 A sound signal is to be digitised for high quality reproduction.

Which of the following statements is/are true?

1 The sound signal should be sampled at half the highest frequency present in the signal.

2 The bits per sample determine the resolution of the signal amplitude.

3 Noise on a digital signal is less problematic than on an analogue signal.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

6 A digital camera has 8 megapixels. Each pixel codes 14 bits of information. A photographer requires a memory card which could hold 120 images.

What is the minimum capacity of the card that they should purchase?

A 1.7 Mbyte

B 13 Mbyte

C 1.7 Gbyte

D 13 Gbyte

Your answer ☐ **[1]**

7 A current of 3 μA flows through a resistor for 1.5 minutes.

How much charge flows through the resistor during this time?

A 4.5×10^{-6} C

B 2.7×10^{-4} C

C 4.5×10^{-3} C

D 2.7×10^{-1} C

Your answer ☐ **[1]**

8 Two electrical heating coils **L** and **M** are made from wires of the same material. The wires are of equal length but different diameters. **L** runs at twice the voltage of **M** but both coils dissipate the same power.

What is the correct conductance ratio for the two coils $G_{\mathbf{L}} / G_{\mathbf{M}}$?

A $\frac{1}{4}$

B $\frac{1}{2}$

C 2

D 4

Your answer ☐ **[1]**

The circuit in **Fig.9.1** below is referred to in both question 9 and 10.

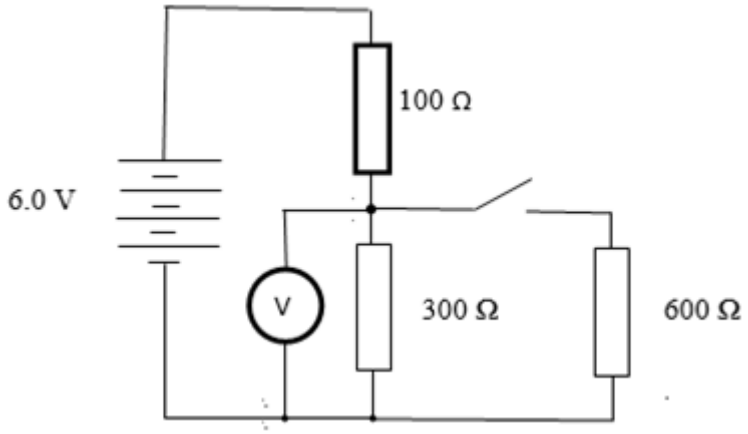


Fig. 9.1

9 The switch in this circuit is **open**.

What is the potential difference across the 100 Ω resistor?

A 1.5 V

B 2.0 V

C 4.5 V

D 6.0 V

Your answer ☐ **[1]**

10 The switch in **Fig.9.1** is now **closed**.

What is the power dissipated in the 100 Ω resistor?

A 0.012 W

B 0.027 W

C 0.040 W

D 0.090 W

Your answer ☐ **[1]**

11 A d.c. supply has an internal resistance of 10 Ω. It is connected to a torch bulb rated at 6.0 V, 0.30 A. The lamp lights to normal brightness.

What is the e.m.f. of the d.c. supply?

A 3.0 V

B 6.0 V

C 9.0 V

D 12 V

Your answer ☐ **[1]**

12 A student correctly uses an ammeter and a voltmeter to measure the resistance of a component. She obtains the readings $I = 0.38 \pm 0.02$ A and $V = 11.75 \pm 0.01$ V.

What is the best estimate for the resistance value and its uncertainty?

A $30.9 \pm 1.6\ \Omega$

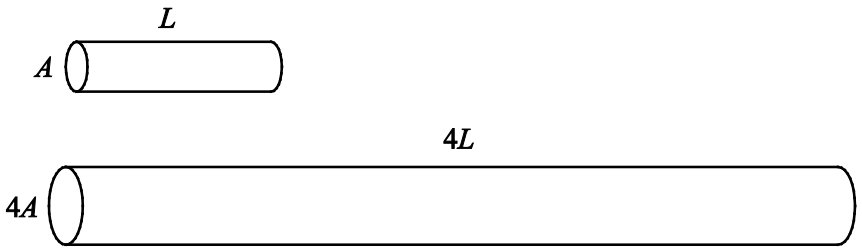
B $30.92 \pm 1.63\ \Omega$

C $30.92 \pm 0.03\ \Omega$

D $31 \pm 2\ \Omega$

Your answer ☐ **[1]**

13 A graph is produced of linear force F (y-axis) against extension x (x-axis) for a metal wire of length L and cross-sectional area A. A second wire of the same material has length $4L$ and cross-sectional area $4A$.



The gradient $k = F/x$ for the second wire will be how many times that for the first wire?

A 1

B 4

C 8

D 16

Your answer ☐ **[1]**

14 Ceramics are brittle materials.

Which of the following statements is/are true?

1 Slip is prevented in ceramics by impurity atoms pinning dislocations.

2 Cracks spread because stress is concentrated at the crack tip.

3 The atoms in the material are bonded in random positions and there are no slip planes.

A 1, 2 and 3

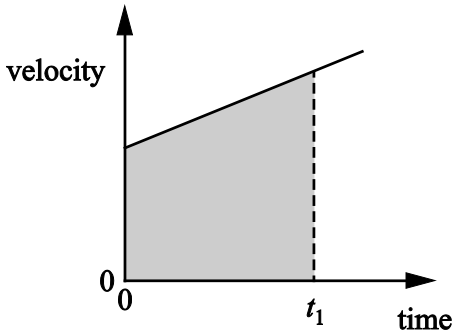
B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

15 Here is a velocity–time graph.



Which statement/s about the graph is/are correct?

1 The gradient represents acceleration.

2 The shaded area represents the change of displacement from time = 0 to time = t_1.

3 The graph shows that velocity is proportional to distance.

A 1, 2 and 3

B Only 1 and 2

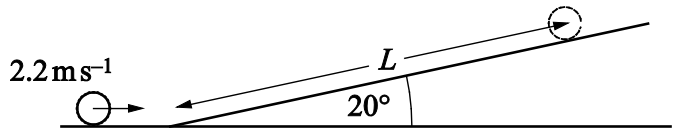
C Only 2 and 3

D Only 1

Your answer ☐

[1]

16 A ball rolls up a ramp which is at angle of 20° to the horizontal. The speed of the ball at the bottom of the ramp is 2.2 m s^{-1}. L is the distance the ball moves along the ramp before coming to rest.



What is distance L? Ignore the effects of friction and rotation in your answer.

A 0.25 m

B 0.26 m

C 0.68 m

D 0.72 m

Your answer ☐

[1]

17 A firework rocket with a mass of 0.40 kg is launched vertically upwards with an initial acceleration of 6.2 ms^{-2}.

What is the force on the rocket from the burning fuel?

A 1.4 N

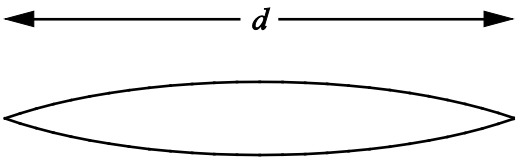
B 2.5 N

C 3.9 N

D 6.4 N

Your answer ☐ **[1]**

18 A standing wave is formed on a string of length *d* as shown.



Which of the following statements is/are true?

1 Progressive waves are travelling along the string in both directions.

2 The standing wave is an example of superposition.

3 The wavelength of the standing wave is *d*.

A 1, 2 and 3

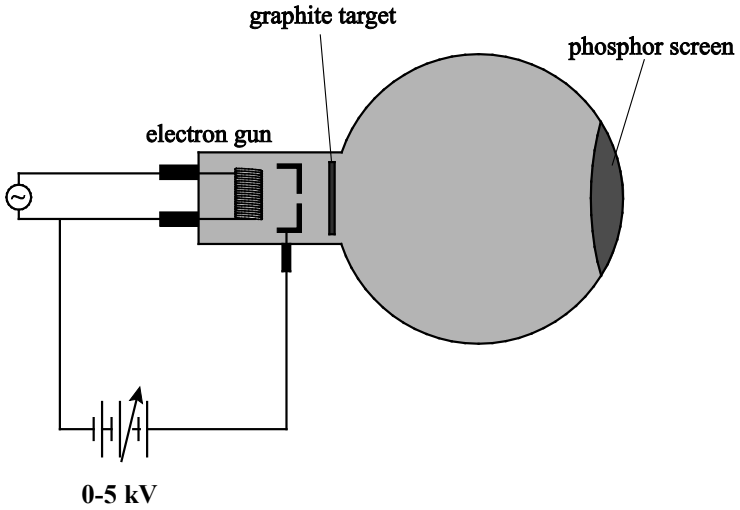
B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

19 In the apparatus shown in the diagram, a beam of electrons hits the graphite target. This target acts as a diffraction grating. Diffraction maxima are seen on the phosphor screen.



When the voltage of the power supply is increased, the diffraction maxima become brighter and closer to the centre of the pattern.

Which of the following statements correctly describe the effect of increasing the voltage?

1 The kinetic energy of the electrons increases.

2 The wavelength of the electrons increases.

3 The charge of the electrons increases.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

20 An electron has a kinetic energy of 2.0×10^{-17} J. The mass of an electron is 9.1×10^{-31} kg.

What is the value for the de Broglie wavelength of the electron?

A 1.1×10^{-10} m

B 1.5×10^{-10} m

C 3.3×10^{-17} m

D 6.6×10^{-17}m

Your answer ☐ **[1]**

SECTION A

You should spend a maximum of 25 minutes on this section.

You should put the letter of the correct answer in the box provided.

Answer **all** the questions.

1 Here is a list of combinations of base units of the SI system.
Which combination gives the correct units of momentum?

A $kg\ m\ s^{-1}$

B $kg\ m\ s^{-2}$

C $kg\ m^{-1}\ s^{-2}$

D $kg\ m^{-2}\ s^{-2}$

Your answer ☐

[1]

2 Here is a list of combinations of base units of the SI system.
Which combination of units is equivalent to pascal, Pa?

A $kg\ m\ s^{-1}$

B $kg\ m\ s^{-2}$

C $kg\ m^{-2}\ s^{-2}$

D $kg\ m^{-1}\ s^{-2}$

Your answer ☐

[1]

3 Polythene, a polymer, is strong and flexible. Which one of the following statements is correct?

A All polymers are flexible.

B Polymers do not extend plastically.

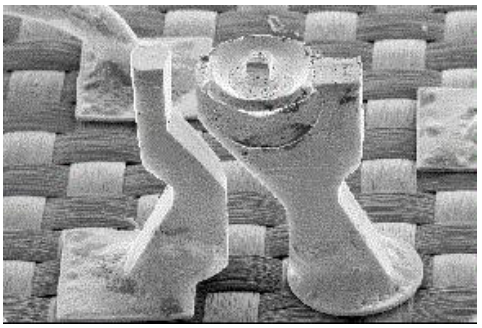
C The bonds in polythene molecules can rotate as the material is stretched.

D Mobile dislocations weaken polymers.

Your answer ☐

[1]

4 The image shown is of an LED and is 290 x 195 pixels. 6 bits per pixel are used for the greyscale levels.



What is the best estimate for the total information in bytes in the uncompressed image?

A 2^6

B 4.2×10^4

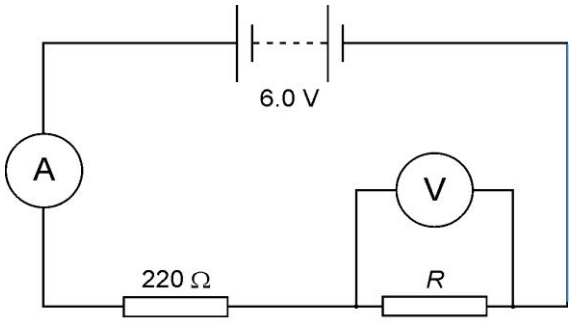
C 5.7×10^4

D 3.4×10^5

Your answer ☐

[1]

5 An unknown resistor *R* and a 220 Ω resistor are connected to a 6.0 V battery of negligible internal resistance as shown.



The reading on the voltmeter is 4.1 V.
What should be the reading on the ammeter?

A 8.6 mA

B 13 mA

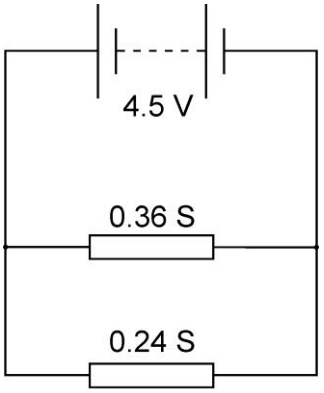
C 19 mA

D 27 mA

Your answer ☐

[1]

6 Two conductors of conductances 0.24 S and 0.36 S are connected in parallel to a 4.5 V battery of negligible internal resistance as shown.



What is the power dissipated in the two conductors?

A 2.9 W

B 4.9 W

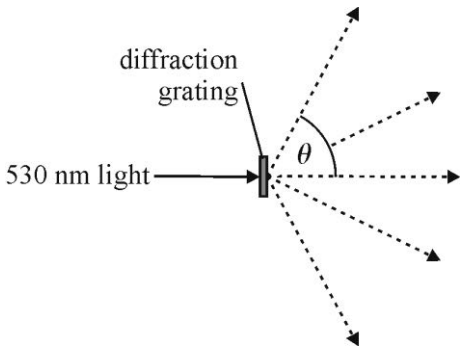
C 7.3 W

D 12 W

Your answer ☐

[1]

7 A diffraction grating which has 830 lines mm^{-1} is illuminated with light of wavelength 530 nm.



What is the angle θ of the second-order diffraction maximum shown, expressed to two significant figures?

A 0.46 rad

B 1.1 rad

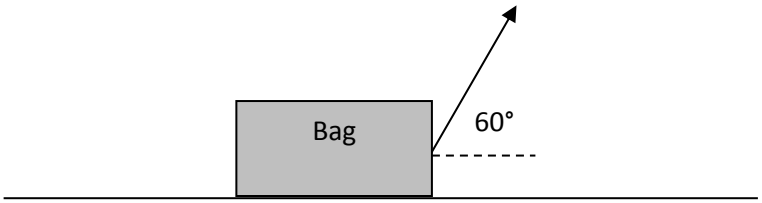
C 26 rad

D 62 rad

Your answer ☐

[1]

8 A bag weighing 50 N is pulled along the ground with a force of 20 N at an angle of 60° to the horizontal as shown in the diagram.



The bag is pulled through a horizontal distance of 6.0 m. How much work has been done pulling the bag?

A 60 J

B 104 J

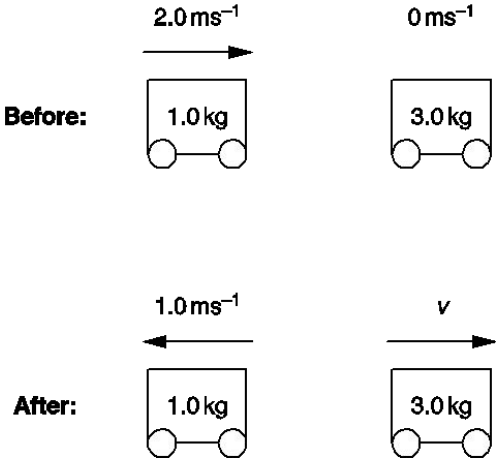
C 120 J

D 300 J

Your answer ☐

[1]

9 The diagram shows the speed and direction of two trolleys before and after a collision:



What is the velocity, *v*, of the 3 kg trolley after the collision?

A 0.33 ms^{-1}

B 1.0 ms^{-1}

C 2.3 ms^{-1}

D 3.0 ms^{-1}

Your answer ☐

[1]

10 Which of these statements correctly describes the properties of a ceramic material?

A Ceramics are hard, stiff and tough.

B Ceramics are weak, stiff and ductile.

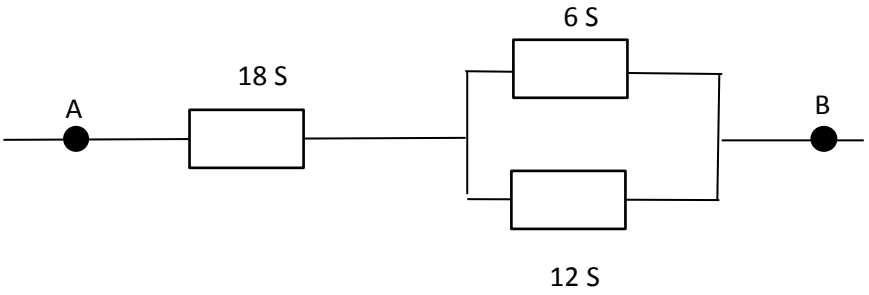
C Ceramics are strong, stiff and brittle.

D Ceramics are strong, flexible and tough.

Your answer ☐

[1]

11 The diagram shows part of an electrical circuit. The conductances of the three components have been labelled.



What is the total conductance between **A** and **B**?

A 9 S

B 18 S

C 22 S

D 36 S

Your answer ☐

[1]

12 A lamp is placed 0.50 m from a converging lens. The power of the lens is +5.0 D.
What is the distance from the lens to the focused image?

A 0.14 m

B 0.20 m

C 0.33 m

D 0.45 m

Your answer ☐

[1]

13 A resistor *R* dissipates power *P* when a p.d. *V* is connected across it. How will the power dissipated change when both the resistance and the p.d. are halved?

A The power doubles

B The power remains the same

C The power halves

D The power quarters

Your answer ☐

[1]

14 A battery of e.m.f 6.0 V is connected to a 4.0 Ω resistor. The p.d. across the terminals of the battery is 5.8 V. What is the internal resistance of the battery?

A 0.03 Ω

B 0.05 Ω

C 0.14 Ω

D 0.16 Ω

Your answer ☐

[1]

15 An elastic spring, of force constant k = 200 N m^{-1}, is extended by 7 cm. What is the energy stored in the spring at this extension?

A 0.49 J

B 0.98 J

C 7.0 J

D 14.0 J

Your answer ☐

[1]

16 An electron of kinetic energy E has a de Broglie wavelength λ. What is the de Broglie wavelength of an electron of kinetic energy 2 E ?

A $2\,\lambda$

B $\sqrt{2}\,\lambda$

C $/\sqrt{2}$

D $/$

Your answer ☐

[1]

17 A wire of length 2.000 m extends to 2.005 m when a 19.6 N weight is hung from it. The diameter of the wire is 0.36 mm. What is the Young modulus of the material of the wire?

A 3.5×10^6 Pa

B 1.4×10^7 Pa

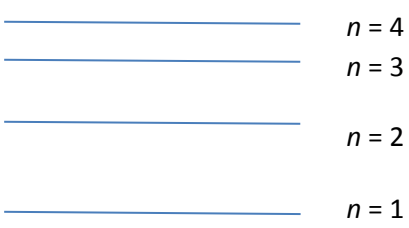
C 1.9×10^{10} Pa

D 7.7×10^{10} Pa

Your answer ☐

[1]

18 Figure 18 shows four electron energy levels. Photons are released when an electron drops from one level to another. How many different frequencies of photons can be released from transitions between the energy levels shown?



A 3

B 4

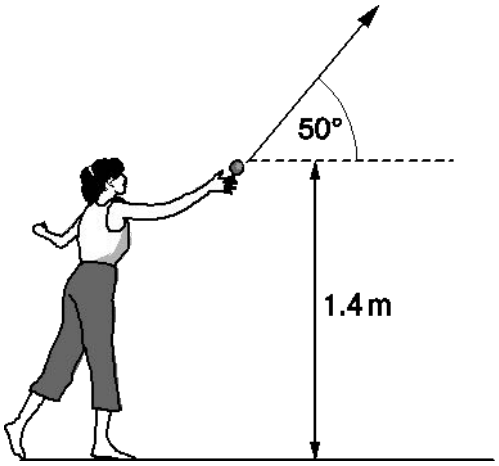
C 5

D 6

Your answer ☐

[1]

19 A ball is thrown at an angle of 50^{o} from a height of 1.4 m with an initial velocity of 15 m s^{-1}. What is the maximum height reached by the ball?



A 3.3 m

B 4.7 m

C 6.7 m

D 8.1 m

Your answer ☐

[1]

20 Which of these terms relates to the force per unit area at which a material begins to deform plastically?

A Breaking stress

B Breaking strain

C Yield stress

D Yield strain

Your answer ☐

[1]

SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

Write your answer to each question in the box provided.

1 Which one of these ratios does **not** have units?

A $\frac{\text{acceleration}}{\text{gravitational field strength}}$

B $\frac{\text{Planck constant}}{\text{momentum}}$

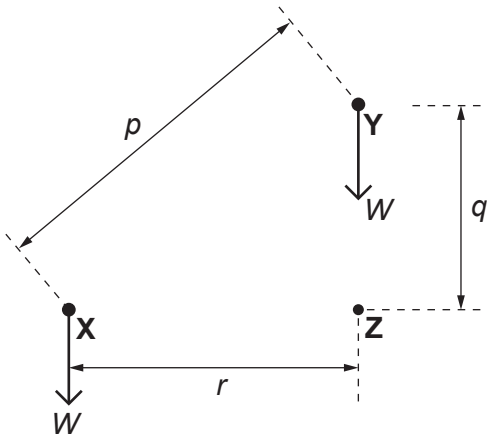
C $\frac{\text{resistance}}{\text{conductance}}$

D $\frac{\text{Young modulus}}{\text{strain}}$

Your answer ☐

[1]

2 A crane is used to lift a load directly from point **X** to point **Y**.



The weight of the load is *W*.
p, q and *r* are distances between points **X**, **Y** and **Z** as shown in the diagram.

What is the work done against the weight?

A Wp

B Wq

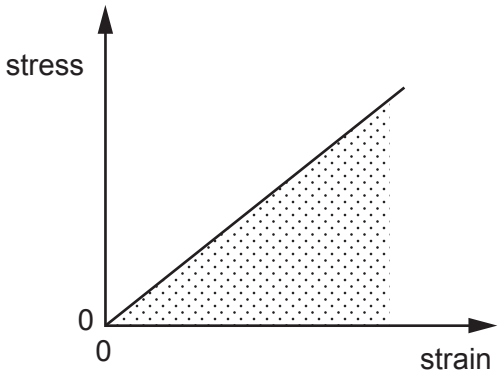
C Wr

D $W(q + r)$

Your answer ☐

[1]

3 The graph shows the variation in stress with strain for a sample of a material.



Which of the following statements is **not** correct?

A The material shows elastic deformation.

B The area under the graph represents the energy stored in the stretched material.

C The gradient gives the Young modulus of the material.

D The graph would show the same gradient for a longer specimen of the same material.

Your answer ☐

[1]

4 Which word used to describe materials does **not** apply to ceramics?

A hard

B stiff

C strong

D tough

Your answer ☐

[1]

5 Here is a list of combinations of base units of the SI system.

Which combination is equivalent to the unit pascal, Pa?

A $kg\,m^{-1}\,s^{-2}$

B $kg\,m\,s^{-2}$

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

D $kg\,m^{2}\,s^{-2}$

Your answer ☐

[1]

6 Waves from an object 0.5 m away pass through a lens of focal length 0.2 m.

Which of the following give the curvature of the waves entering the lens and leaving the lens?

	Curvature entering lens / D	**Curvature leaving lens / D**
A	–2.0	+5.0
B	+2.0	+5.0
C	–2.0	+3.0
D	+2.0	+7.0

Your answer ☐

[1]

7 The display of a laptop screen is viewed through a polarising filter by a student. The intensity of the light changes when the filter is rotated.

Which property of light is demonstrated in this experiment?

A It has wavelength of about 5×10^{-7} m.

B It travels at the speed of light.

C It is a transverse wave.

D It is a longitudinal wave.

Your answer ☐

[1]

8 In which region of the electromagnetic spectrum is radiation of wavelength 50 μm?

A visible

B infra-red

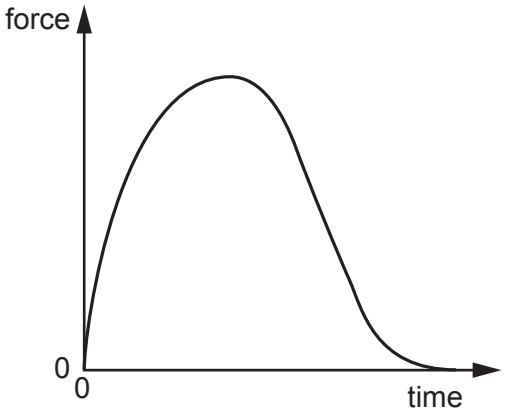
C microwave

D radio

Your answer ☐

[1]

9 The graph shows the resultant force on a football as it is kicked.



Which of the following graphs relating to this kick would have the same shape as the graph above?

A acceleration of the ball against time

B kinetic energy of the ball against time

C momentum of the ball against time

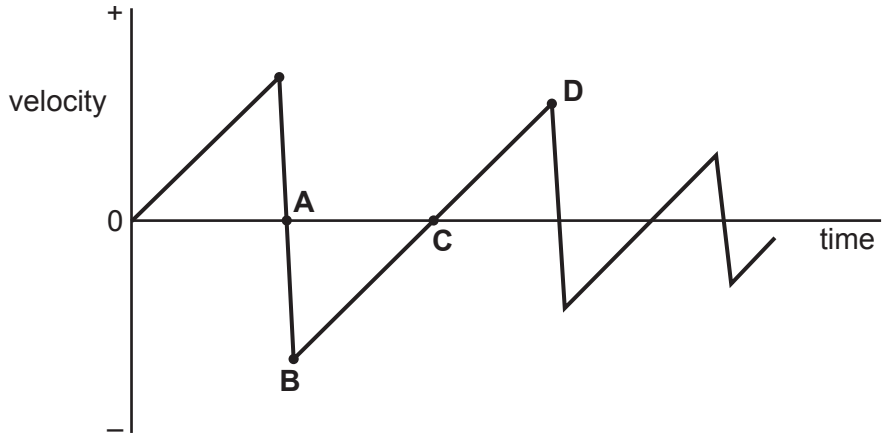
D velocity of the ball against time

Your answer ☐

[1]

10 A golf ball is dropped from rest onto a hard floor.
The graph shows how the velocity of the ball varies with time as it bounces, from the time of release.

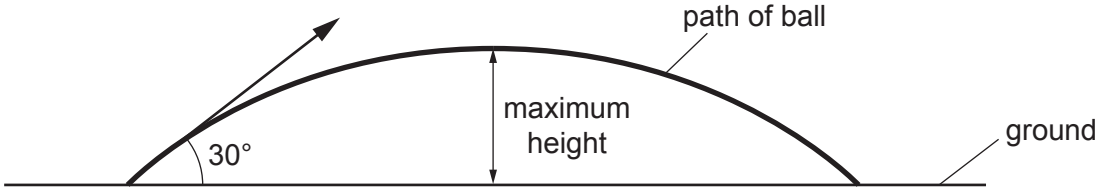
At which point does the ball reach its maximum height after the first bounce?



Your answer ☐

[1]

11 A ball is thrown at an angle of 30° to the horizontal. The initial kinetic energy of the ball is *K*.
Air resistance has negligible effect on the motion of the ball.



What is the kinetic energy of the ball at the maximum height?

A 0

B 0.25 *K*

C 0.75 *K*

D 0.87 *K*

Your answer ☐

[1]

12 Ball **P** has mass m. Ball **Q** has mass $2m$. Both balls have the same kinetic energy, which is greater than zero.

What is the ratio $\frac{\text{momentum of } \mathbf{P}}{\text{momentum of } \mathbf{Q}}$?

A $\frac{1}{2}$

B $\frac{1}{\sqrt{2}}$

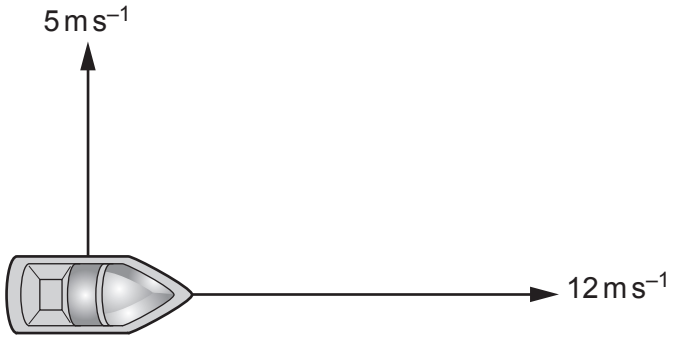
C $\sqrt{2}$

D 2

Your answer ☐

[1]

13 A boat is travelling eastwards across the sea with a velocity of $12\,m\,s^{-1}$. A wind from the south pushes the boat northwards at a velocity of $5\,m\,s^{-1}$.



What is the magnitude of the resultant velocity of the boat as it travels across the sea?

A $7\,m\,s^{-1}$

B $13\,m\,s^{-1}$

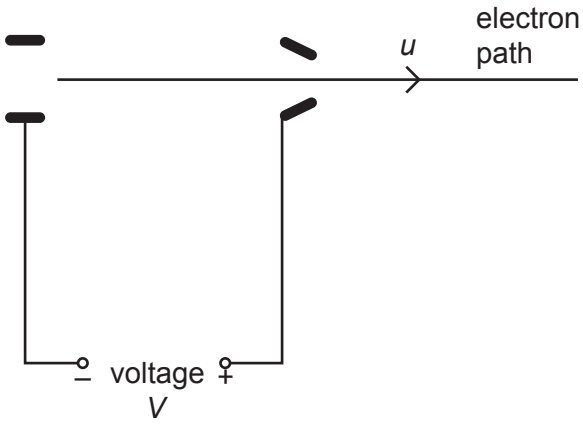
C $17\,m\,s^{-1}$

D $169\,m\,s^{-1}$

Your answer ☐

[1]

14 An electron gun is used to accelerate electrons from rest through a voltage V. The electrons emerge with a speed u.



The voltage in the gun is halved to $\frac{V}{2}$. At what speed do the electrons emerge?

A $\frac{u}{4}$

B $\frac{u}{2}$

C $\frac{u}{\sqrt{2}}$

D $u\sqrt{2}$

Your answer ☐

[1]

15 The solar constant is the average power per square metre that the Sun provides at the surface of the Earth. The solar constant at the solar array on the International Space Station (ISS) is $1360\,\text{W}\,\text{m}^{-2}$. One section of the solar array has an area of $406\,\text{m}^2$.

Assuming that all of the solar energy is converted into electrical energy aboard the ISS, how much electricity is produced by one section of the solar array in one hour?

A 150 J

B 12 kJ

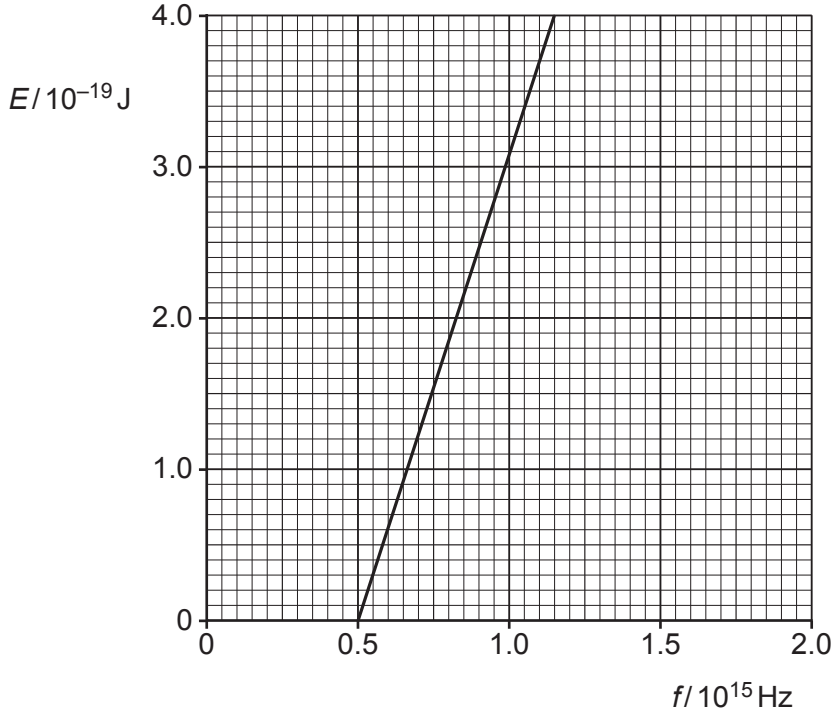
C 0.6 MJ

D 2.0 GJ

Your answer ☐

[1]

16 The graph below shows how the maximum kinetic energy E of electrons released from the surface of a potassium plate varies with frequency f of electromagnetic radiation incident on the plate.



To **two significant figures**, what is the value of the Planck constant that can be calculated from this graph?

A 6.2×10^{-34} J s

B 6.6×10^{-34} J s

C 6.2×10^{4} J s

D 1.6×10^{33} J s

Your answer ☐

[1]

17 A digital voltmeter of very high resistance is connected across the terminals of a source of e.m.f. The voltmeter reads 12 V.

When an analogue voltmeter with a resistance of 1000 Ω is connected across the terminals of the same source of e.m.f, it reads 8 V.

What are the correct values for the e.m.f $\mathcal{E}$ and internal resistance r of the source?

A $\mathcal{E} = 8\,V$ $r = 500\,\Omega$

B $\mathcal{E} = 8\,V$ $r = 1000\,\Omega$

C $\mathcal{E} = 12\,V$ $r = 500\,\Omega$

D $\mathcal{E} = 12\,V$ $r = 1000\,\Omega$

Your answer ☐

[1]

18 The rear window of a car is heated by passing an electric current through a grid of wires that are fixed to the glass. The grid is made up of five wires connected in parallel.

Each wire is a thin rectangular strip of steel 80 cm long, 3.0 mm wide and 50 μm thick with resistivity 470 nΩ m.

What is the total resistance of the wires in the grid?

A 0.50 Ω

B 2.5 Ω

C 13 Ω

D 50 Ω

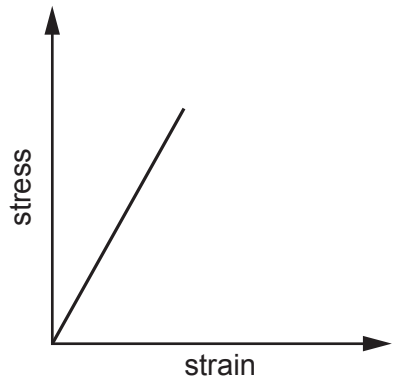
Your answer ☐

[1]

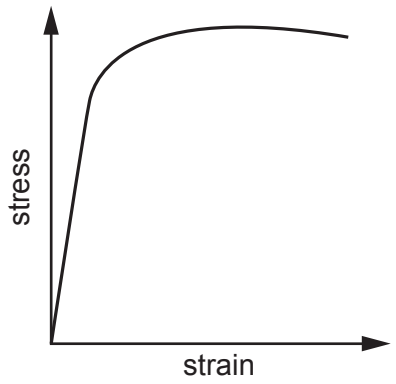
19 The graphs below show the stress against strain relationships for four different materials, **A**, **B**, **C** and **D**. Each graph has the same scales.

Which of the graphs shows a ductile material with the highest Young modulus?

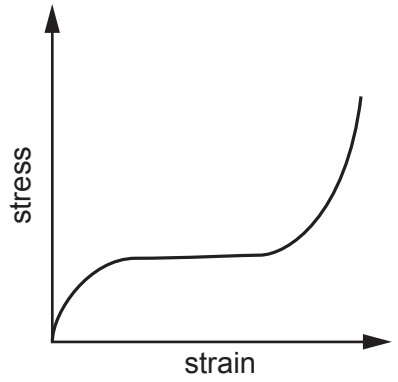
A



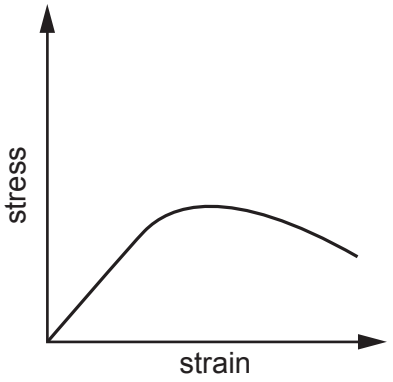
B



C



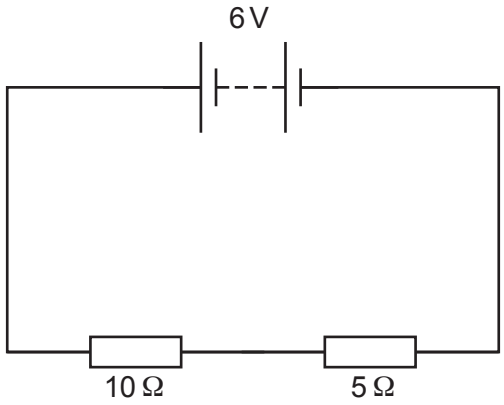
D



Your answer ☐

[1]

20 In the diagram below, the battery of e.m.f 6 V has negligible internal resistance.



What is the power dissipated in the 10 Ω resistor in the circuit shown?

A 0.4 W

B 0.9 W

C 1.6 W

D 3.6 W

Your answer

[1]

SECTION A

You should spend a maximum of 40 minutes on this section.

Answer **all** the questions.

1 The isotope of radon $^{220}_{86}\text{Rn}$ decays by a series of transformations to a final stable product.
The particles emitted during the transformations are $\alpha,\ \alpha,\ \beta,\ \beta,\ \alpha$.

Which of the isotopes below is the final product of the decay series?

A $^{206}_{82}\text{Pb}$

B $^{207}_{82}\text{Pb}$

C $^{208}_{82}\text{Pb}$

D $^{212}_{84}\text{Po}$

Your answer ☐

[1]

2 An imagined atom can exist in five energy levels. Transitions between all levels are possible.

Which statement about the imagined atom is correct?

A When the atom jumps to a lower level an electron gains energy.

B When the atom emits a photon the atom jumps to a higher energy level.

C There will be six frequencies in the line spectrum of the atom.

D There will be ten frequencies in the line spectrum of the atom.

Your answer ☐

[1]

3 A proton is accelerated until its total energy is double its rest energy.

What is its speed, expressed in terms of the speed of light, c?

0.25c

B 0.50c

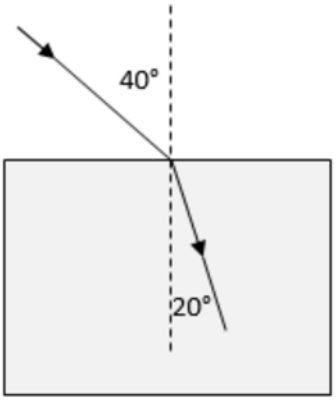
C 0.75c

D 0.87c

Your answer ☐

[1]

4 A ray of light passes from air into a rectangular glass block.



The refractive index of the glass is

0.53

B 0.82

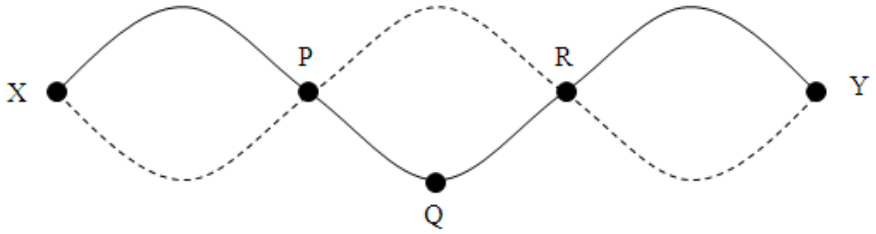
C 1.2

D 1.9

Your answer ☐

[1]

5 The solid line shows the standing wave pattern of a vibrating string which is fixed at ends X and Y. The broken line shows the position of the string half a cycle later. The displacement at point Q is a maximum.



Which one of these statements is true?

A The distance from P to R is one wavelength.

B A short time later, the string at R will move up.

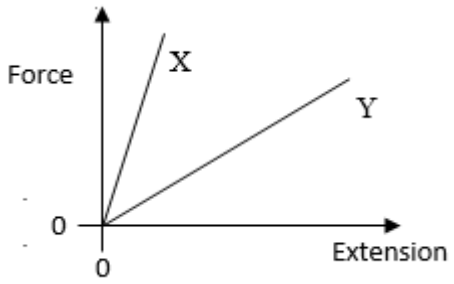
C The lowest possible frequency for this string is one third of its current value.

D The kinetic energy of the string has its maximum value.

Your answer ☐

[1]

6 This is a force–extension graph for two different materials, X and Y. The materials are stretched up to the point at which they fracture.



Which one of these statements about the materials is true?

A Y is stiffer than X

B both materials are tough

C X stores more energy than Y

D X and Y obey Hooke's law

Your answer ☐

[1]

7 Source **A** is a radioisotope with a half-life of 2 hours. Source **B** is a radioisotope with a half-life of 4 hours.
The initial activity of source **A** is twice that of source **B**.

How long will pass before the activity of source **B** is twice that of source **A**?

A 4 hours

B 6 hours

C 8 hours

D 12 hours

Your answer ☐

[1]

8 Here is the equation for beta decay:

1 number of quarks

2 lepton number

3 charge number

A 1, 2 and 3

B Only 1 and 2

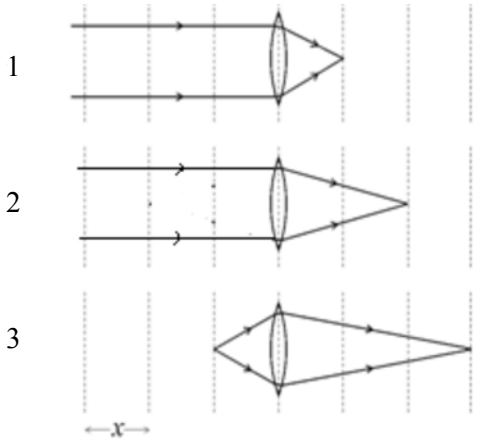
C Only 2 and 3

D Only 1

Your answer ☐

[1]

9 The diagrams 1, 2 and 3 show three different lenses forming images.
In each diagram, the dotted lines are equally-spaced and separated by the same distance *x*.



Which, if any, of the lenses have power $P = \frac{1}{x}$?

A None

B lens 1

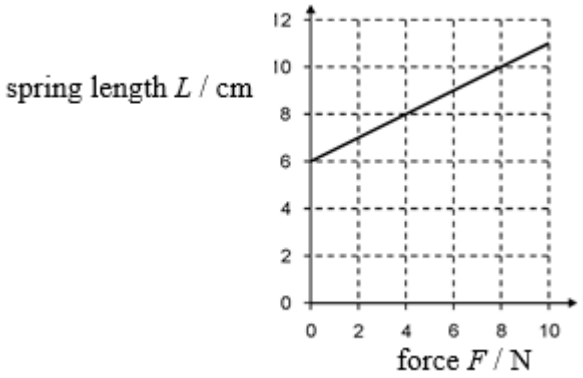
C lens 2

D lens 3

Your answer ☐

[1]

10 The graph shows the variation of length L of a spring with the stretching force F.



Which is the best estimate of the work done in stretching the spring over the range given by the graph?

A 0.25 J

B 0.85 J

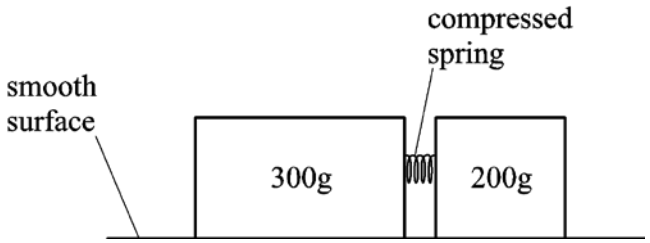
C 85 J

D 200 J

Your answer ☐

[1]

11 The diagram shows two blocks of different masses resting on a smooth surface. They are held together so that a spring between them is in compression.



The blocks are released, and the spring pushes them apart.
The maximum speed of the 200 g mass is 4.2 m s^{-1}.

What is the maximum speed of the 300 g mass?

A 6.3 m s^{-1}

B 2.1 m s^{-1}

C 2.8 m s^{-1}

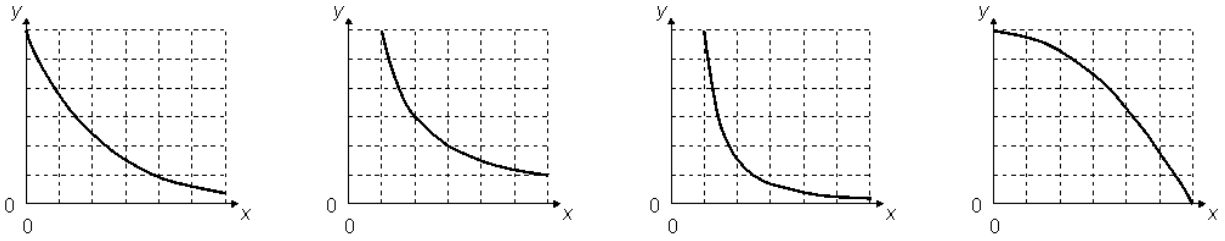
D 1.4 m s^{-1}

Your answer ☐

[1]

The following information is for use in questions **12** and **13**.

The graphs **A**–**D** represent different relationships between variables. The dotted lines mark out equal intervals along the *x*- and *y*-axes.



A **B** **C** **D**

12 Which graph **A**, **B**, **C**, or **D** best represents the relationship between the variables *x* and *y* where:

y is the pressure of a fixed mass of gas at room temperature
x is the volume occupied by that gas.

Your answer ☐

[1]

13 Which graph **A**, **B**, **C**, or **D** best represents the relationship between the variables *x* and *y* where:

y is the electric field strength in the space surrounding a point change
x is the distance from the point charge.

Your answer ☐

[1]

14 Four different ions enter a region of uniform magnetic field. Each ion enters with the same velocity. The magnetic field acts at 90º to the path of the ions. Each ion is defined below in terms of its nucleon number and charge.

Which ion will travel in a circular path with the largest radius?

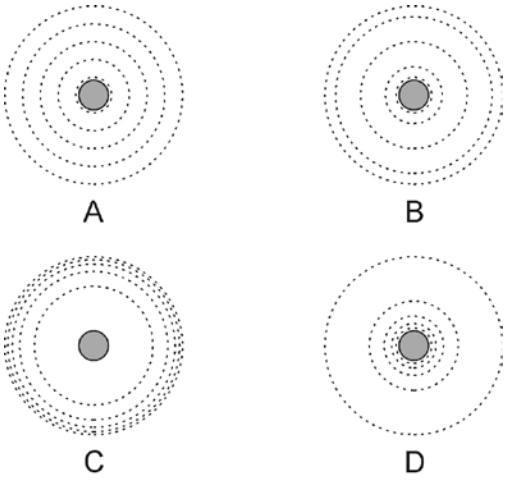
	nucleon number	**charge**
A	1	1
B	2	1
C	3	1
D	7	2

Your answer ☐

[1]

15 Here are four diagrams of possible equipotentials near an isolated star.
In each diagram, the difference in gravitational potentials between adjacent equipotentials is the same.

Which diagram is correct?



Your answer ☐

[1]

16 A satellite orbits the Earth in a circular orbit of height 2.3×10^6 m above the ground.

What is the angular velocity ω of the satellite?

radius of Earth = 6.4×10^6 m.
mass of Earth = 6.0×10^{24} kg

A 6.1×10^{-7} rad s^{-1}

B 3.3×10^{-5} rad s^{-1}

C 7.8×10^{-4} rad s^{-1}

D 5.7×10^{-3} rad s^{-1}

Your answer ☐

[1]

17 The up quark (u) has charge +⅔e and the down quark (d) a charge of –⅓e.

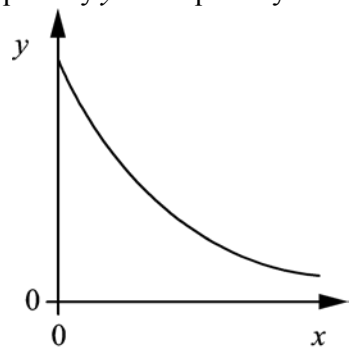
What is the correct combination of quarks that make up the proton and the neutron?

	proton	**neutron**
A	ddd	uud
B	udd	uud
C	uud	udd
D	ddd	udd

Your answer ☐

[1]

18 The graph shows the variation in quantity y with quantity x.



Which pair(s) of quantities produce a similar graph?

1 mass remaining of a radioisotope (y) against time (x)

2 charge (y) on a capacitor against potential difference (x) across the capacitor

3 gravitational field strength from a point mass (y) against distance from mass (x)

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐

[1]

19 Two small metal spheres have the same electric charge. The distance between the centres of the spheres is 12 cm. The force on each sphere is 0.29 mN.

What is the electric charge on each sphere?

A 4.6×10^{-16} C

B 4.6×10^{-9} C

C 2.2×10^{-8} C

D 6.8×10^{-5} C

Your answer ☐

[1]

20 $^{210}_{84}\text{Po}$ is a radioactive isotope. The equation for its decay is:

$$^{210}_{84}\text{Po} \rightarrow X + \alpha + \gamma$$

Where X is the daughter nucleus, α is an alpha particle and γ is a gamma photon.

What is the atomic number of X?

A 80

B 82

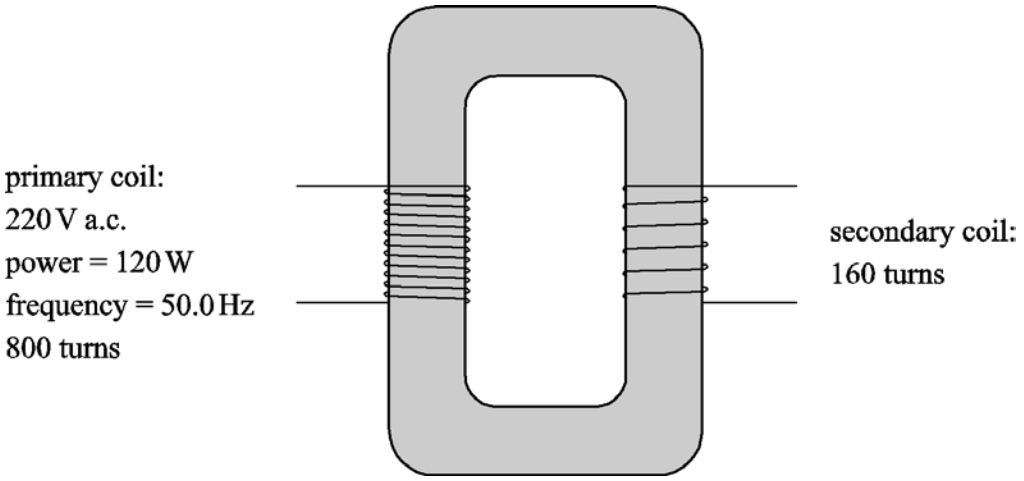
C 85

D 208

Your answer ☐

[1]

21 The diagram shows an ideal transformer.



Which of the following data sets about the output of the secondary coil is correct?

	p.d. / V	***I* / A**	***f* / Hz**
A	44.0	2.73	10.0
B	44.0	0.11	50.0
C	44.0	2.73	50.0
D	1100	0.11	50.0

Your answer ☐

[1]

22 A 4700 μF capacitor is discharged through a 2200 Ω resistor. To the nearest second, how long will it take for the charge on the capacitor to fall to half its original value?

A 3 s

B 5 s

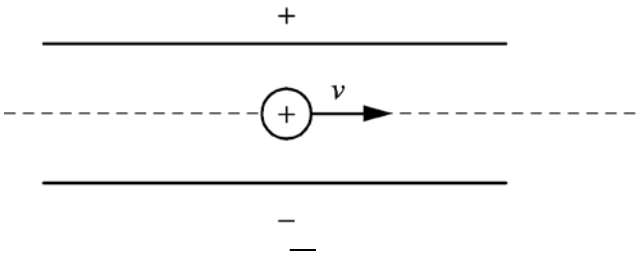
C 7 s

D 10 s

Your answer ☐

[1]

23 A proton enters the space between two oppositely charged parallel metal plates.



A magnetic field acts between the plates at right angles to the electric field and the direction of motion of the proton.
The magnetic field strength is 20 mT and the electric field strength is 100 V m^{-1}.
The proton moves in a straight line between the plates.

What is the speed of the proton?

A 2000 m s^{-1}

B 5000 m s^{-1}

C 5 m s^{-1}

D 2 m s^{-1}

Your answer ☐

[1]

24 Here are some data about a volume of an ideal gas:

volume = 0.5×10^{-3} m^3
pressure = 0.25 MPa
temperature = 30 °C

What is the number of particles in the volume of gas?

A 3×10^{20}

B 3×10^{21}

C 3×10^{22}

D 3×10^{23}

Your answer ☐

[1]

The following information is for use in questions **25** and **26.**

A proton ${}_{1}^{1}p$ and a ${}_{2}^{4}\mathrm{He}$ nucleus (alpha particle) are both accelerated from rest through a potential difference of 1000 V.

25 What is the ratio $\frac{kinetic\ energy\ of\ the\ proton}{kinetic\ energy\ of\ the\ alpha\ particle}$?

A $\frac{1}{4}$

B $\frac{1}{2}$

C $\frac{2}{1}$

D $\frac{4}{1}$

Your answer ☐

[1]

26 What is the ratio $\frac{momentum\ of\ the\ proton}{momentum\ of\ the\ alpha\ particle}$?

A $\frac{1}{2\sqrt{2}}$

B $\frac{1}{\sqrt{2}}$

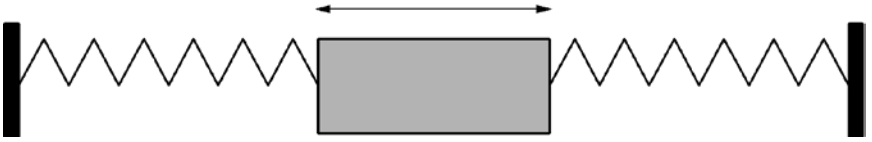
C $\frac{\sqrt{2}}{1}$

D $\frac{2\sqrt{2}}{1}$

Your answer ☐

[1]

27 A mass M oscillates in simple harmonic motion between two fixed supports. Frictional effects can be ignored. The time period of the oscillation is T_1.



The mass is replaced with a mass of 4 M **and** the amplitude of the oscillation is doubled. The new time period is T_2.

Which is the correct statement?

A $T_2 = 4\ T_1$

B $T_2 = 2\ T_1$

C $T_2 = T_1$

D $T_2 = ½\ T_1$

Your answer ☐

[1]

28 The activation energy E_A for the conduction of a semiconductor diode is 0.14 eV. The operating temperature of the diode in a circuit is measured at 85 ± 4 ºC. A student is considering the effect this uncertainty causes in the calculation of the Boltzmann factor $e^{-E_A/kT}$.

Which of the following statements is/are true?

1 The % uncertainty in the Boltzmann factor will be the same as in the temperature.

2 Temperatures should be expressed on the absolute scale in Kelvins for calculations with the Boltzmann factor.

3 The % uncertainty in T is 1.5% to two significant figures.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 is correct

D Only 1 is correct

Your answer ☐

[1]

The following information is for use in questions **29** and **30**.

The ratio of masses $\frac{M_{\text{Earth}}}{M_{\text{Moon}}} \approx 80$ and the ratio of radii $\frac{r_{\text{Earth}}}{r_{\text{Moon}}} \approx 4$.

29 What is the best estimate of the ratio of gravitational fields at the surface of the two bodies $\frac{g_{\text{Earth}}}{g_{\text{Moon}}}$?

A 1.6

B 5

C 20

D 320

Your answer ☐

[1]

30 What is the best estimate of the ratio of gravitational potentials at the surface of the two bodies $\frac{V_{\text{Earth}}}{V_{\text{Moon}}}$?

A 1.6

B 5

C 20

D 320

Your answer ☐

[1]

SECTION A

You should spend a maximum of 40 minutes on this section.

Write your answer for each question in the box provided.

Answer **all** the questions.

1 Which pair contains one vector and one scalar quantity?

A velocity acceleration

B distance force

C kinetic energy power

D momentum displacement

Your answer ☐

[1]

2 Which one of the following could **not** be used as a unit of stress?

A Pa

B $N\ m^{-2}$

C $J\ m^{-3}$

D $kg\ m\ s^{-2}$

Your answer ☐

[1]

3 Which experimental procedure reduces systematic error of the quantity being measured?

A timing a large number of oscillations to find the period of a pendulum

B measuring the diameter of a wire several times to find an average

C adjusting a voltmeter to remove its zero error before measuring a p.d.

D repeating readings of the activity of a radioactive rock before taking an average

Your answer ☐

[1]

4 Which quantity is followed by a reasonable estimate of its magnitude?

A wavelength of green light 500 nm

B frequency of a radio wave 900 GHz

C mass of a bee 800 µg

D volume of water for a bath 3000 mm^3

Your answer ☐

[1]

5 A signal is being digitized by sampling at 2.0 kHz.
The total voltage is 3.0 V and the noise voltage is 5.9 mV.

Which statement is **not** correct?

A $\frac{V_{total}}{V_{noise}} \approx 500$

B The recommended number of bits per sample is 9

C The highest frequency in the signal should not exceed 1.0 kHz

D The voltage resolution of the sampling should be less than 3.0 mV

Your answer ☐

[1]

The following information is for use in questions **6** and **7**.

Here are some statements about the conduction electrons in a copper wire at room temperature.

A They are moving freely through the wire.

B They are moving rapidly and at random making collisions with each other and with the copper ions.

C They are drifting slowly along the wire making collisions with each other and with the copper ions.

D They are drifting slowly along the wire but are also moving rapidly and at random, making collisions with each other and with the copper ions.

6 Which of the above statements best describes the motion of conduction electrons when there is no current in the wire?

Your answer ☐

[1]

7 Which of the above statements best describes the motion of conduction electrons when there is a constant current in the wire?

Your answer ☐

[1]

8 Which statement about mechanical properties of materials is **not** correct?

A Cracks are a common way in which a brittle material can fail mechanically.

B A material with a high Young modulus will be very stiff.

C The tensile strength of a stiff material can be relatively small.

D If a material is tough it will also usually be brittle.

Your answer ☐

[1]

9 For the strain of two different stretched wires to be the same they must have the same ratio of

A stress to Young modulus.

B tension to cross-sectional area.

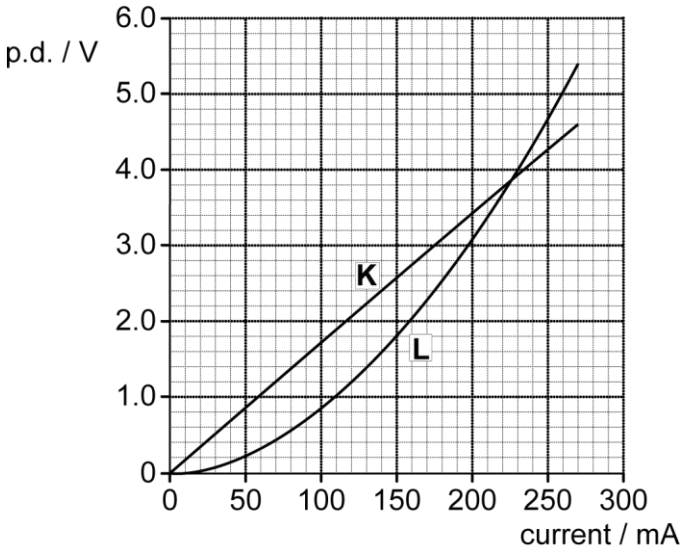
C tension to extension.

D tension to original length.

Your answer ☐

[1]

10 The $V - I$ graphs of two electrical components **K** and **L** are shown below.



Which statement is **not** correct?

A **K** is a resistor and **L** is a filament lamp.

B The resistance of **L** increases as the current in it increases.

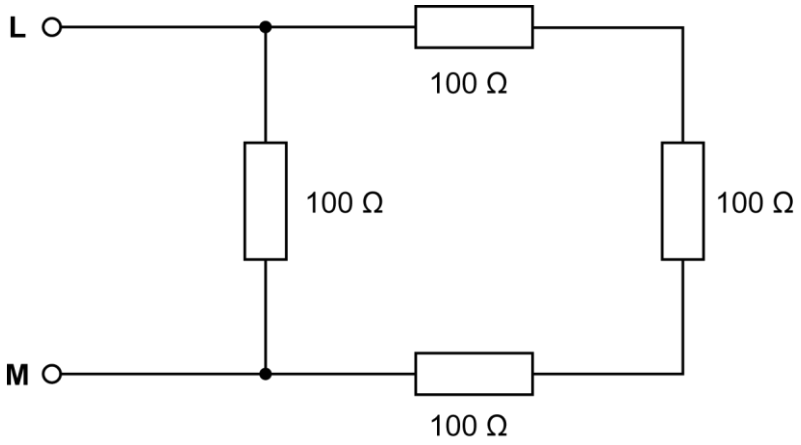
C Up to 3.8 V the conductance of **K** is larger than the conductance of **L.**

D **K** and **L** have equal resistance where the graphs intersect at 3.8 V.

Your answer ☐

[1]

11 The diagram shows an arrangement of equal resistors.



What is the total electrical resistance between **L** and **M**?

A less than 10 Ω

B between 10 Ω and 100 Ω

C between 100 Ω and 300 Ω

D 400 Ω

Your answer ☐

[1]

12 Kirchhoff's two laws for electric circuits can be derived from conservation laws.

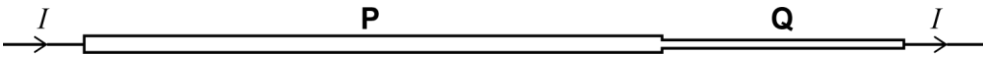
On which conservation laws do Kirchhoff's laws depend?

	Kirchoff's first law	**Kirchoff's second law**
A	mass	energy
B	current	mass
C	charge	energy
D	energy	current

Your answer ☐

[1]

13 A long thick length **P** of tungsten wire is connected in series with a shorter thinner length **Q** of tungsten wire to a variable power supply. The current I in them is adjusted so that when heated by the current their resistances become equal. The wires are not equally hot, **P** is just warm while **Q** glows red.



Which of the following statements about this experiment is/are correct?

1 The potential difference across each wire is the same.

2 The power dissipated in **P** > power dissipated in **Q.**

3 When the current is switched off and the wires have returned to room temperature, the resistances of **P** and **Q** remain equal.

A 1, 2 and 3 are correct

B only 1 and 2 are correct

C only 2 and 3 are correct

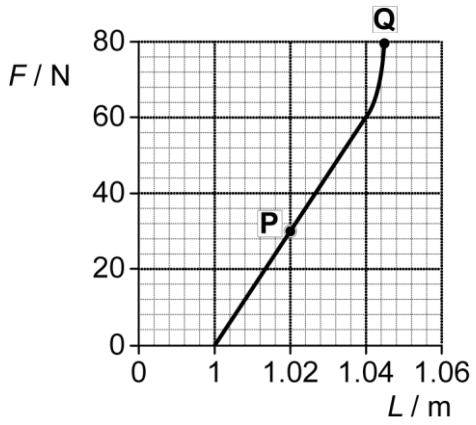
D only 1 is correct

Your answer ☐

[1]

Question 14 begins on page 8

14 The graph shows how the length of a perspex strip varies with tension force *F*.
The strip has a cross-sectional area of 4 mm^2 when it breaks at **Q**.



Which of the following statements agree with this data?

1 The strain at **P** is 2%.

2 The breaking stress is 20 x 10^6 Pa.

3 Hooke's law is obeyed up to a strain of 0.04.

A 1, 2 and 3 are correct

B only 1 and 2 are correct

C only 2 and 3 are correct

D only 1 is correct

Your answer ☐

[1]

15 Suppose a certain atom has only four possible energy levels.

What would be the maximum number of different energies of photons that it could emit?

A 3

B 4

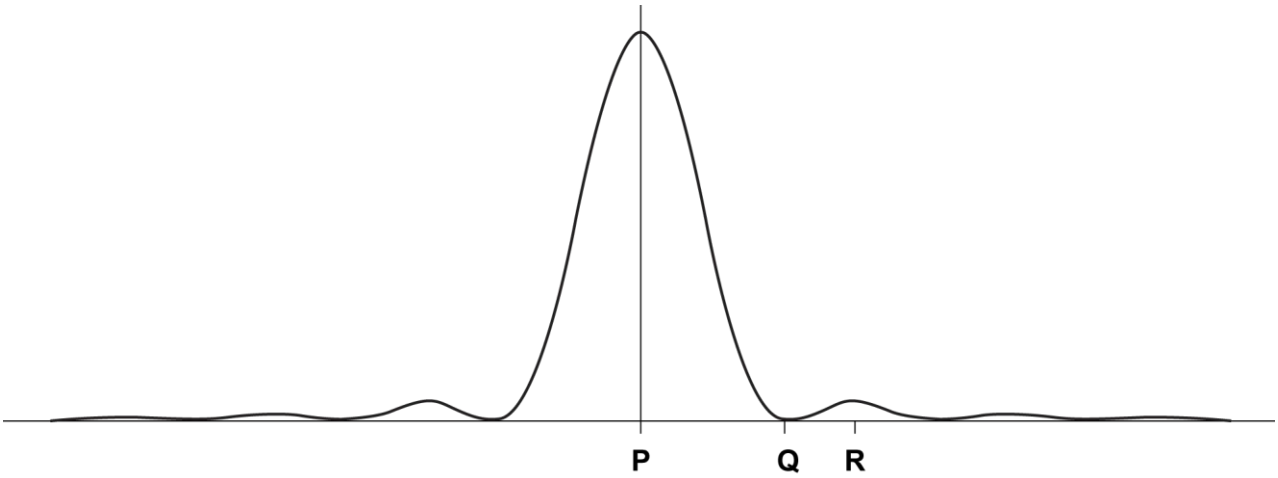
C 6

D 8

Your answer ☐

[1]

16 Laser light is passed through a single slit onto a distant screen.
The graph illustrates the variation of intensity with position on the screen.



Which of the following statements about the positions **P**, **Q** and **R** on the screen is/are correct?

1 At **P** all the phasors from different positions across the slit line up to give a large resultant.

2 At **Q** phasors from different positions across the slit curl up to give zero resultant.

3 At **R** the probability of arrival of a photon will increase if the slit is made a little narrower.

A 1, 2 and 3 are correct

B only 1 and 2 are correct

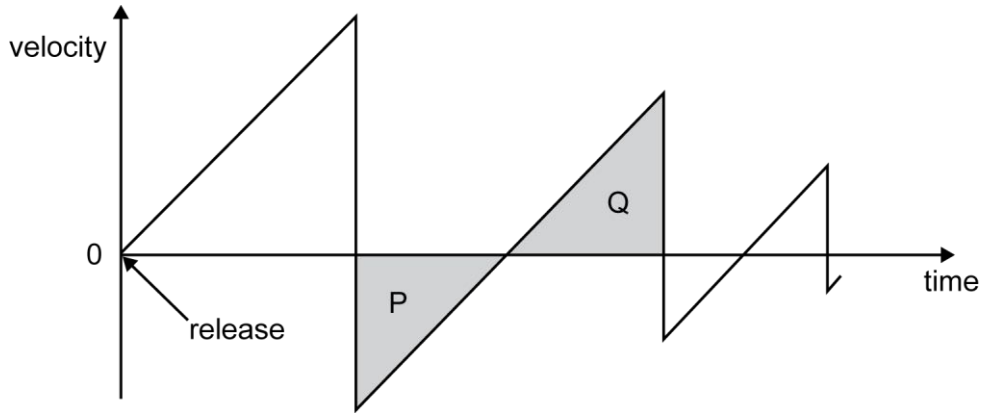
C only 2 and 3 are correct

D only 1 is correct

Your answer ☐

[1]

17 A ball is released from rest above a horizontal surface and bounces.
The graph shows how the velocity of the ball varies with time.



Which statement best explains why areas **P** and **Q** equal?

A The ball's acceleration is constant between bounces.

B At each bounce the ball loses a fraction of its kinetic energy.

C The ball rises and falls through the same distance between bounces.

D After a bounce the ball leaves the surface with the same speed at which it hits the surface for the next bounce.

Your answer ☐

[1]

18 Here is a list of oscillators.

1 infrared radiation

2 mains voltage

3 a simple pendulum 1 metre long

Which of the following sequences correctly places them in order of increasing frequency?

A 2 1 3

B 2 3 1

C 3 1 2

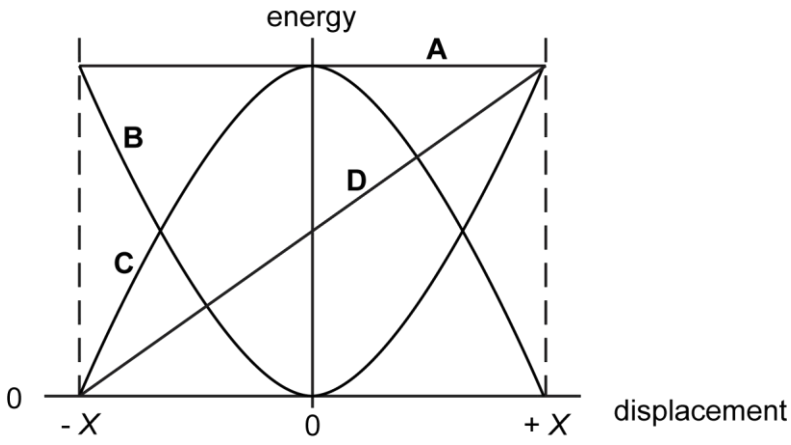
D 3 2 1

Your answer ☐

[1]

The following information is for use in questions **19** and **20**.

The graphs **A** to **D** may plot energy against displacement for a harmonic oscillator.
The oscillator vibrates in a straight line with amplitude *X*.



19 Which graph represents the total energy of the harmonic oscillator?

Your answer ☐

[1]

20 Which graph represents the kinetic energy of the harmonic oscillator?

Your answer ☐

[1]

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

1 It is reasonable to infer that both γ-rays and radio waves are electromagnetic because they both carry energy.

2 It is reasonable to expect to be able to polarise electromagnetic waves because they are transverse.

3 It is reasonable to expect to observe diffraction of electromagnetic waves of frequency 2×10^8 Hz by an object 1.5 m in diameter since electromagnetic waves travel at 3×10^8 m s^{-1}.

A 1, 2 and 3 are correct

B only 1 and 2 are correct

C only 2 and 3 are correct

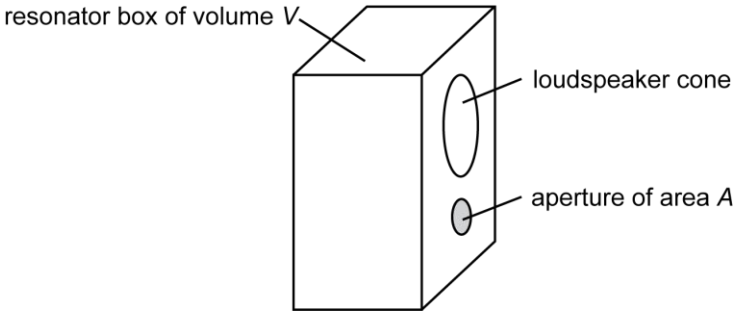
D only 1 is correct

Your answer ☐

[1]

The following information is for use in questions **22** and **23**.

Bass speakers can be mounted in a box to act as a resonator at natural frequency *f.*
The box has a volume *V* and an aperture of area *A* cut into its front as shown.



The resonator frequency f is given by $f^2 = \frac{k A^{\frac{1}{2}}}{V}$ where k is a constant.

The designer wants to make the aperture a circle of radius r.

22 How does the volume V vary with r when the resonant frequency f is kept constant?

A V is proportional to $\frac{1}{r}$

B V is proportional to r^2

C V is proportional to $r^{\frac{1}{2}}$

D V is proportional to r

Your answer ☐

[1]

23 How does the resonant frequency f vary with r when the volume V is kept constant?

A f is proportional to $\frac{1}{r}$

B f is proportional to r^2

C f is proportional to $r^{\frac{1}{2}}$

D f is proportional to r

Your answer ☐

[1]

24 The decay of a nucleus of strontium-90 is shown by the equation

$$^{90}_{38}\text{Sr} \rightarrow {}^{90}_{39}\text{Y} + {}^{0}_{-1}\text{e} + {}^{0}_{0}\bar{\nu}$$

What happens to the total charge number, nucleon number and lepton number as a result of this decay?

	charge number	**nucleon number**	**lepton number**
A	decreases	conserved	increases
B	conserved	conserved	conserved
C	conserved	conserved	decreases
D	increases	decreases	conserved

Your answer ☐

[1]

Question 25 begins on page 14

The following information is for use in questions **25** and **26**.

Two radioactive sources of equal mass are freshly prepared.
One is a β emitter ^{225}Ra with a half-life of 15 days.
The other is an α emitter ^{225}Ac with a half-life of 10 days.

25 After 30 days, which one of **A** to **D** below gives the ratio: $\frac{\text{number of } ^{225}\text{Ra atoms}}{\text{number of } ^{225}\text{Ac atoms}}$?

A 2.0

B 1.33

C 1.0

D 0.5

Your answer ☐

[1]

26 After 30 days, which one of **A** to **D** below gives the ratio: $\frac{\text{activity of } ^{225}\text{Ra atoms}}{\text{activity of } ^{225}\text{Ac atoms}}$?

A 2.0

B 1.33

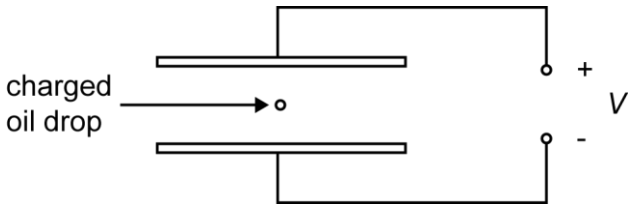
C 1.0

D 0.5

Your answer ☐

[1]

27 The diagram shows a charged oil drop between two parallel plates connected to a high **constant** voltage *V*.



Which of the following correctly describe(s) changes to the electrical force on the drop?

1 If the plates were closer together, the electrical force on the drop would be larger.

2 If the drop acquires more charge the electrical force on it increases.

3 If the drop moves nearer to the top plate the electrical force on it increases.

A 1, 2 and 3 are correct

B only 1 and 2 are correct

C only 2 and 3 are correct

D only 1 is correct

Your answer ☐

[1]

28 The differently charged ions of several isotopes are all fired at the same speed. They pass into a region of uniform magnetic flux density perpendicular to their path.

Which of the ions **A** to **D** will travel in the circular path of **smallest** radius?

A $^{6}_{3}Li^{+}$

B $^{6}_{3}Li^{2+}$

C $^{12}_{6}C^{2+}$

D $^{14}_{6}C^{4+}$

Your answer ☐

[1]

29 Which of the following three values is/are required to calculate the speed v of a satellite of mass m in a circular orbit of radius r around the Earth?

1 the mass m of the satellite

2 the radius r of the orbit

3 GM (the gravitational constant G x M the mass of the Earth)

A 1, 2 and 3 are correct

B only 1 and 2 are correct

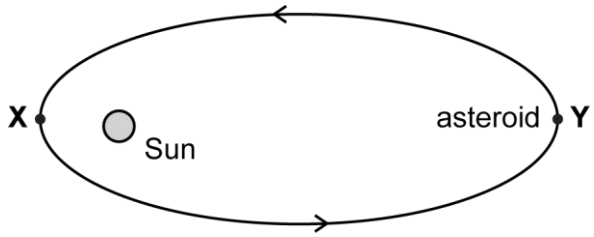
C only 2 and 3 are correct

D only 1 is correct

Your answer ☐

[1]

30 An asteroid moves around the Sun in an ellipse, as shown. It is closest to the Sun at **X** and furthest from the Sun at **Y**.



Which one of the following quantities is greater at **Y** than at **X**?

A the gravitational force on the asteroid due to the Sun

B the kinetic energy of the asteroid

C the speed of the asteroid in its orbit

D the gravitational potential energy of the Sun-asteroid system

Your answer ☐

[1]

SECTION A

You should spend a maximum of 40 minutes on this section.

Write your answer for each question in the box provided.

Answer **all** the questions.

1 Which unit could be used for conductance?

A $W\,A^{-1}$

B $A^2\,\Omega$

C $V\,A^{-1}$

D $A\,V^{-1}$

Your answer ☐

[1]

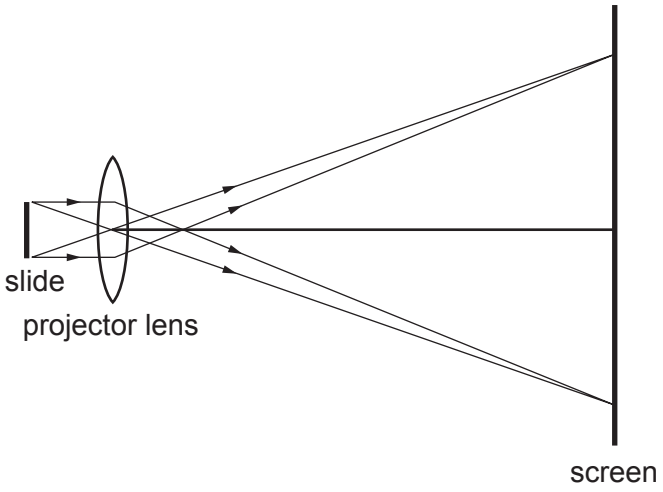
2 Which of the following pairs consist of one scalar and one vector?

A	acceleration	displacement
B	force	distance
C	temperature	energy
D	work	density

Your answer ☐

[1]

3 A slide projector is set up to give a focused image on a fixed screen.



Which set of adjustments could give a larger focused image on the screen?

	Movement of slide	**Movement of projector**
A	away from the lens	away from the screen
B	away from the lens	towards the screen
C	towards the lens	away from the screen
D	towards the lens	towards the screen

Your answer ☐

[1]

4 A thin converging lens of focal length *f* produces a real image.

Which of the following is correct?

When the object distance is

A very large the image distance is 2*f*.

B *f* the magnification *M* is 1.

C 2*f* the image distance is *f*.

D larger than *f* but smaller than 2*f* the magnification *M* is larger than 1.

Your answer ☐

[1]

5 An analogue signal with a maximum frequency of 6 kHz is to be digitised.

For the signal $\frac{V_{\text{Total}}}{V_{\text{Noise}}} = 2000$

what is the best estimate of the bit rate needed for the digitised signal?

A 12 Mbit s^{-1}

B 24 Mbit s^{-1}

C 66 kbit s^{-1}

D 132 kbit s^{-1}

Your answer ☐

[1]

6 Two wires of the same length and the same material are connected in parallel across the same battery of negligible internal resistance. Wire X has double the diameter of wire Y.

What is the ratio $\frac{\text{current in X}}{\text{current in Y}}$?

A $\frac{1}{4}$

B $\frac{1}{2}$

C 2

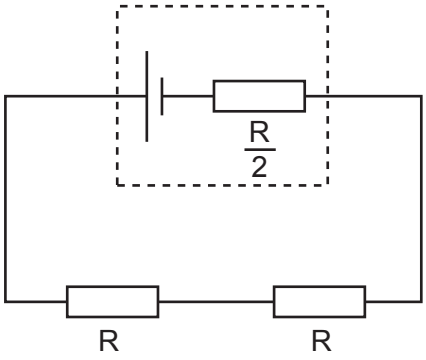
D 4

Your answer ☐

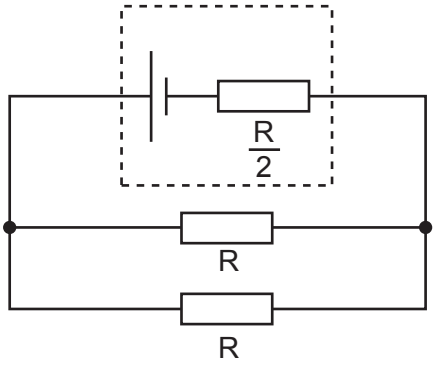
[1]

7 These two circuits have identical components.

The cells have internal resistance $r = \frac{R}{2}$.



circuit 1



circuit 2

What is the ratio $\frac{\text{total resistance of circuit 1}}{\text{total resistance of circuit 2}}$?

A $\frac{5}{2}$

B $\frac{2}{5}$

C $\frac{3}{2}$

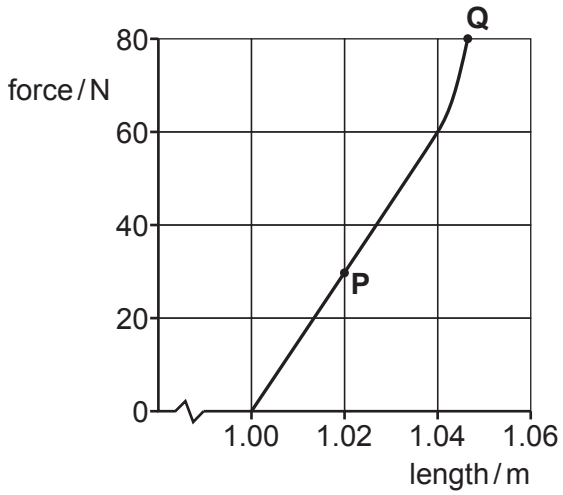
D $\frac{2}{3}$

Your answer ☐

[1]

The following information is for use in questions **8** and **9**.

The graph shows how the length of a plastic rod varies with the force in it.
The rod snaps at **Q**, when its cross-sectional area is $2 \times 10^{-6}\,m^2$.



8 What is the best estimate for the Young modulus of the plastic?

A 10^3 Pa

B 10^6 Pa

C 10^9 Pa

D 10^{11} Pa

Your answer ☐

[1]

9 Which of the following statements is correct?

A The breaking stress is $4.0 \times 10^7\,N\,m^{-2}$.

B Hooke's Law is obeyed up to a force of 60 N.

C The stress at **P** is 0.2%.

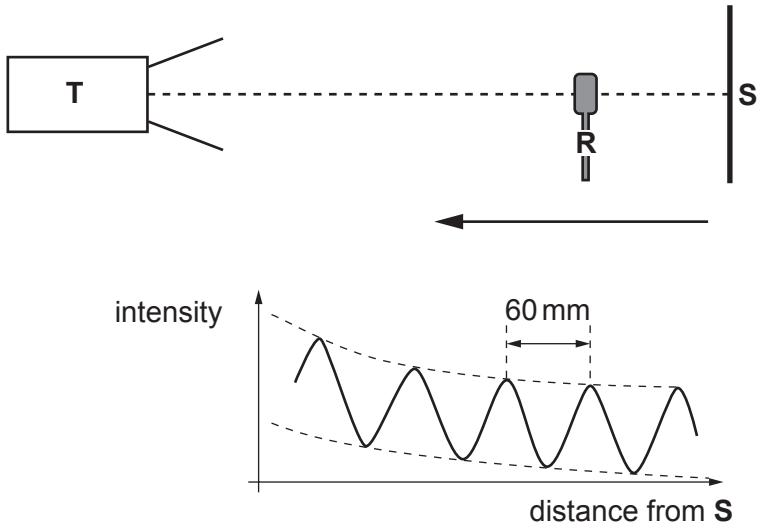
D The strain at **P** is 0.02%.

Your answer ☐

[1]

10 A microwave transmitter **T** is placed at a fixed distance from a flat reflecting surface **S**.

A receiver **R** is moved from **S** towards **T**. The signal received changes in intensity as indicated in the diagram.



Which of the following statements is correct?

A The receiver **R** is measuring the amplitude of a standing wave pattern.

B The frequency of the microwaves is 2.5 GHz.

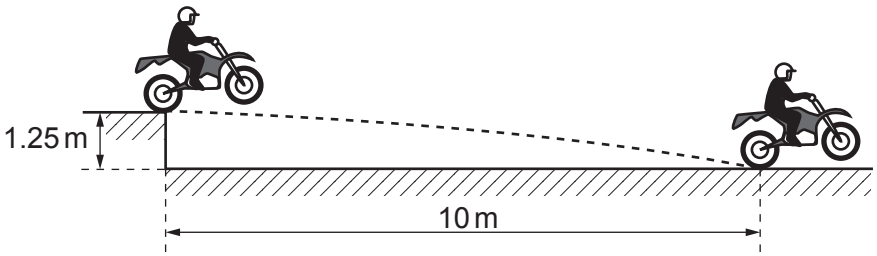
C The wavelength of the microwaves is 6.0 cm.

D The amplitudes of the transmitted and reflected waves at each position are equal.

Your answer ☐

[1]

11 A motorbike launches horizontally from a point 1.25 m above ground, and lands 10 m away as shown.



What was the speed at launch?

A $5\,m\,s^{-1}$

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

C $15\,m\,s^{-1}$

D $20\,m\,s^{-1}$

Your answer ☐

[1]

12 A motorist travelling at $10\,m\,s^{-1}$ brings her car to rest in a braking distance of 10 m.

In what braking distance could she bring the car to rest from an initial speed of $40\,m\,s^{-1}$ using the same braking force under the same road conditions?

A 20 m

B 40 m

C 80 m

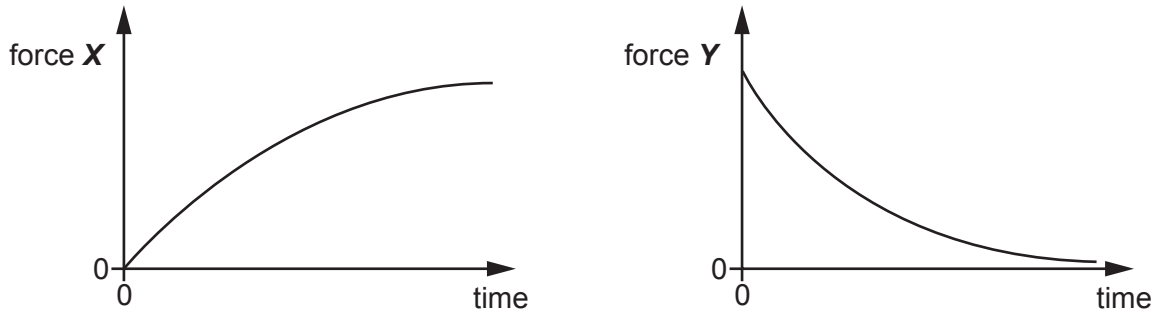
D 160 m

Your answer ☐

[1]

13 A ball falls from rest through air. It reaches terminal velocity.

For this fall forces ***X*** and ***Y*** vary with time as shown.



What are the forces ***X*** and ***Y*** ?

	Force *X*	**Force *Y***
A	air resistance	resultant force
B	air resistance	weight
C	weight	resultant force
D	resultant force	weight

Your answer ☐ **[1]**

14 A student makes measurements and calculates the speed of sound as $328.16\,m\,s^{-1}$.
The experimental uncertainty is ± 3%.

Which of the following expresses the result to an appropriate number of significant figures?

A $300\,m\,s^{-1}$

B $330\,m\,s^{-1}$

C $328\,m\,s^{-1}$

D $328.2\,m\,s^{-1}$

Your answer ☐ **[1]**

15 The mass attached to a spring undergoes simple harmonic motion.

The spring has a spring constant of $25\,\text{N}\,\text{m}^{-1}$.

What is the best estimate for the time period T of the simple harmonic oscillations?

A 0.14 s

B 0.90 s

C 1.1 s

D 7.1 s

Your answer ☐

[1]

16 After 64 days the activity of a radioactive nuclide has fallen to one sixteenth $\left(\frac{1}{16}\right)$ of its original value.

What is the half-life of the radioactive nuclide?

A 2 days

B 4 days

C 8 days

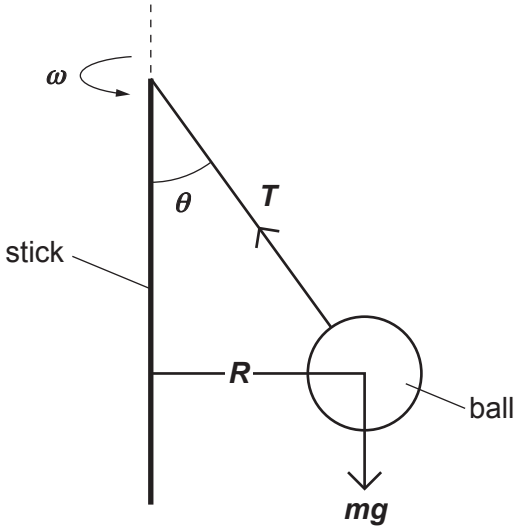
D 16 days

Your answer ☐

[1]

17 A ball of mass ***m*** is suspended on a string from a stick which is rotated at angular speed ω as illustrated below.

The ball moves in a horizontal circle of radius ***R.*** The tension in the string is ***T*** and the angle of the string to the vertical is θ.

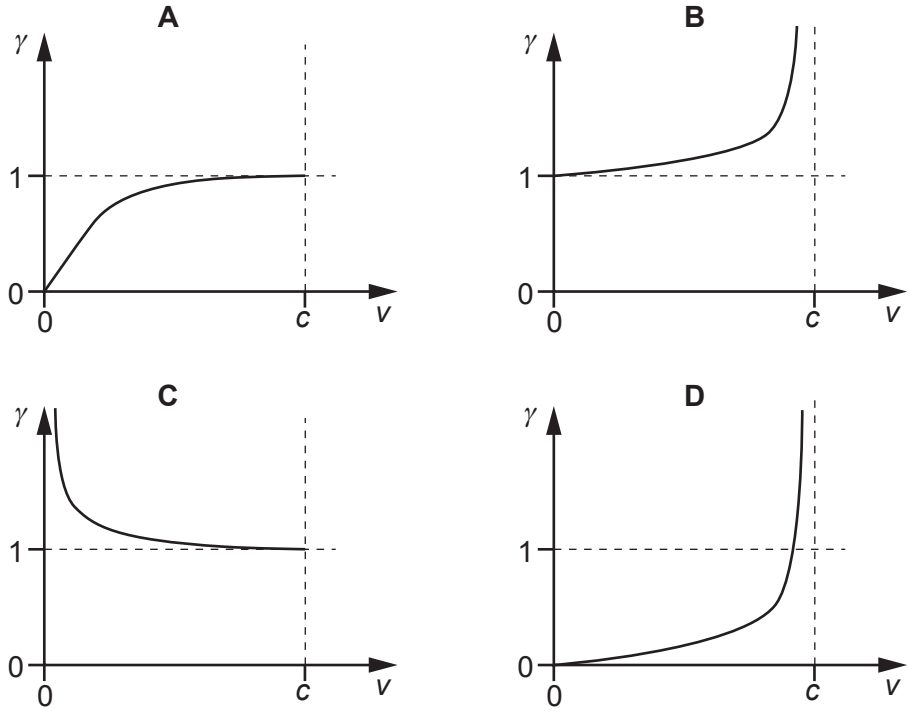


What are the equations for the vertical and horizontal force components of the motion?

	Vertical resolution	Horizontal resolution
A	$mg = T \sin\theta$	$T \cos\theta = m R^2 \omega$
B	$mg = T \sin\theta$	$T \cos\theta = m R \omega^2$
C	$mg = T \cos\theta$	$T \sin\theta = m R^2 \omega$
D	$mg = T \cos\theta$	$T \sin\theta = m R \omega^2$

Your answer ☐ **[1]**

18 Which graph shows the correct relationship between the relativistic γ factor and the speed v of a moving particle?



Your answer ☐ **[1]**

19 Which is the best estimate for the order of magnitude of the energy, in electronvolts, of a photon of visible light?

A 10^{-19} eV

B 10^{-10} eV

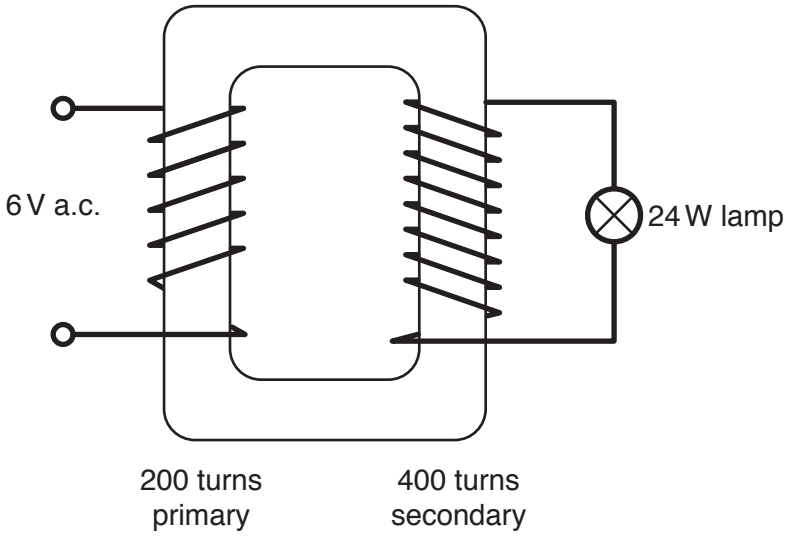
C 1 eV

D 10^{19} eV

Your answer ☐ **[1]**

The following information is for use in questions **20** and **21**.

This diagram shows an ideal transformer.



Here are four values of currents:

A $\frac{1}{4}$ A

B $\frac{1}{2}$ A

C 2 A

D 4 A

20 Which is the best estimate of the current in the secondary circuit?

Your answer ☐ **[1]**

21 Which is the best estimate of the current in the primary circuit?

Your answer ☐ **[1]**

22 Protons and neutrons consist of smaller particles called quarks.

The 'up' quark has a charge + $\frac{2}{3}e$ and the 'down' quark has a charge – $\frac{1}{3}e$, where e is the elementary charge.

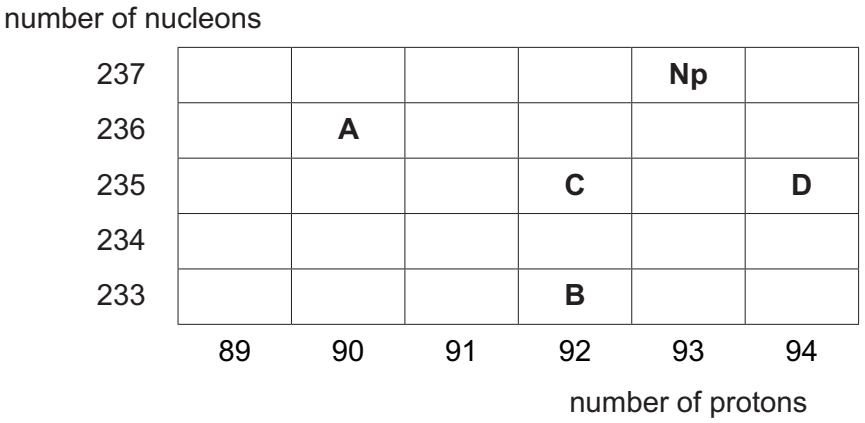
How many up quarks and down quarks must a proton contain?

	Up quarks	**Down quarks**
A	0	3
B	1	1
C	1	2
D	2	1

Your answer ☐

[1]

23 The grid shows the number of nucleons and the number of protons for different nuclides.



The isotope of Neptunium (Np) shown on the grid decays by emitting an alpha particle and then a beta particle.

Which box represents the resulting nuclide?

Your answer ☐

[1]

24 A nucleus X interacts with a neutron and undergoes fission:

$$X + {}^{1}_{0}n \rightarrow {}^{144}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n$$

What is nucleus X?

A ${}^{234}_{92}U$

B ${}^{238}_{92}U$

C ${}^{235}_{92}U$

D ${}^{237}_{93}Np$

Your answer ☐ **[1]**

25 A fixed mass of gas occupies a volume V. The temperature of the gas increases so that the root mean square speed of the molecules doubles. The pressure remains constant.

What is the new volume of the gas?

A $\frac{V}{2}$

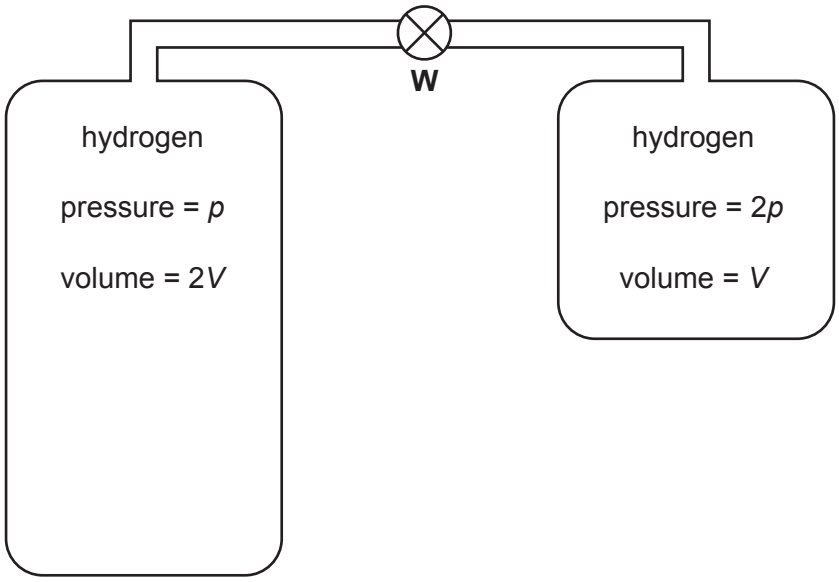
B $\frac{V}{\sqrt{2}}$

C $2V$

D $4V$

Your answer ☐ **[1]**

26 Two large gas bottles are connected by a tube of negligible volume as shown.



Initially the valve **W** is closed.

Valve **W** is opened so that gas can slowly flow, but remain at room temperature.

What is the new gas pressure in the bottles when flow has stopped?

A $\frac{2}{3}p$

B $\frac{4}{3}p$

C $\frac{3}{2}p$

D $\frac{5}{3}p$

Your answer ☐ **[1]**

27 A satellite with orbital speed v takes 24 hours to make one orbit of the Earth, remaining stationary above a fixed point on the Earth's surface.

Which of the following statements is/are correct?

1 Any radius R of orbit is possible, provided that $\frac{2\pi R}{v}$ = 24 hours.

2 It must be in an orbit above the equator.

3 Any mass of satellite can be chosen.

A 1, 2 and 3 are correct

B only 1 and 2 are correct

C only 2 and 3 are correct

D only 1 is correct

Your answer ☐ **[1]**

28 10 kg of water at 90 °C is mixed with 30 kg of water at 30 °C in a warm bath.

Assume there is no energy transferred by heating to the surroundings.

Which of the following statements is/are correct?

1 Energy transferred by heating from the hotter water = energy transferred by heating to the cooler water.

2 The temperature drop of hotter water = 3 × temperature rise of cooler water.

3 The final temperature of the mixture will be 45 °C.

A 1, 2 and 3 are correct

B only 1 and 2 are correct

C only 2 and 3 are correct

D only 1 is correct

Your answer ☐ **[1]**

29 A thick aluminium disc has its plane perpendicular to a uniform magnetic field as in Fig. 29.1. The disc is then turned through 90° until its plane is parallel to the magnetic field as in Fig. 29.2.

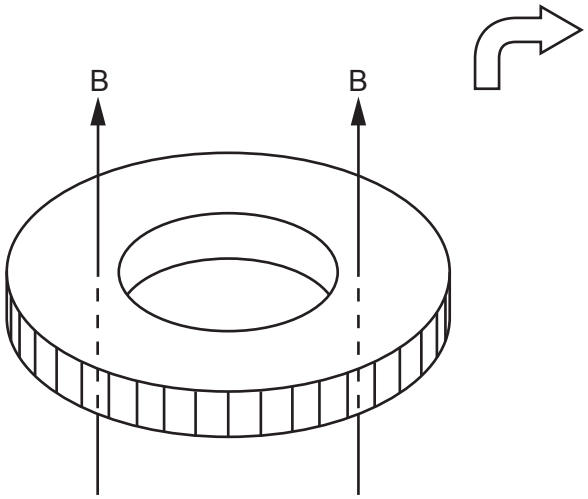


Fig. 29.1

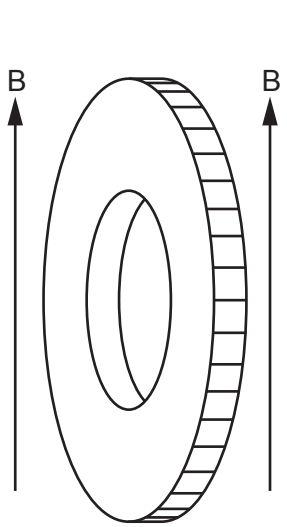


Fig. 29.2

The movement cuts magnetic flux, so there is an induced e.m.f. and hence an induced current is produced in the disc.

This **induced current** could be increased by

A increasing the size of the central hole.

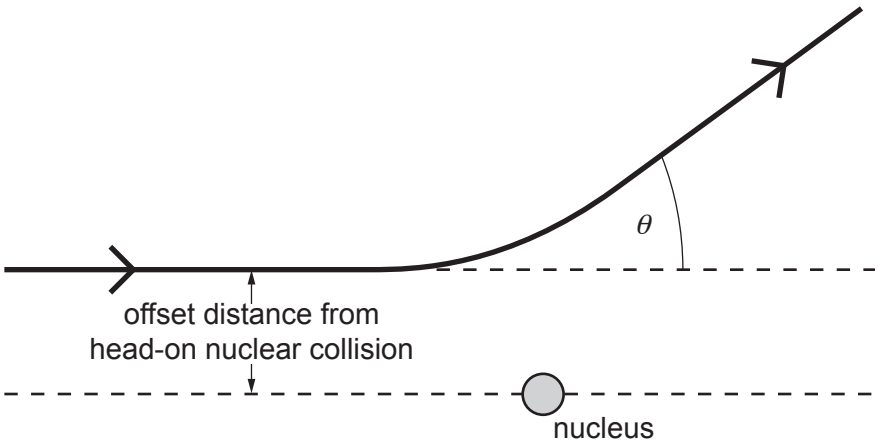
B increasing the speed of turning the disc.

C using metal of a lower conductivity for the disc.

D turning the disc in the opposite direction.

Your answer ☐ **[1]**

30 An α particle approaches an atomic nucleus and is scattered through angle θ.
The path of the particle is offset as shown.



Which of the following changes on its own would cause the scattering angle θ to decrease?

A Use an α particle with lower kinetic energy.

B Have a smaller offset distance for the initial trajectory.

C Use a target nucleus with a smaller charge.

D Use a target nucleus with a larger mass.

Your answer ☐ **[1]**

SECTION A

You should spend a maximum of 40 minutes on this section.

Write your answer for each question in the box provided.

Answer **all** the questions.

1 Which pair contains one vector and one scalar quantity?

A velocity acceleration

B displacement force

C kinetic energy work done

D momentum distance

Your answer ☐ **[1]**

2 The unit of electrical resistance is the ohm Ω. 1 Ω is the same as

A $1\ C\ V^{-1}$

B $1\ S^{-1}$

C $1\ C^2\ J^{-1}\ s^{-1}$

D $1\ A\ V^{-1}$

Your answer ☐ **[1]**

3 Which quantity is followed by a reasonable estimate of its order of magnitude?

A weight of an apple 10^0 N

B volume of a table tennis ball 10^3 cm^3

C wavelength of infra-red radiation 10^4 m

D temperature of Sun's surface 10^5 K

Your answer ☐ **[1]**

4 A signal is being digitised by sampling at 12 kHz.
The total voltage is 5.0 V and the noise voltage is 4.9 mV.

Which statement is correct?

A $\frac{V_{total}}{V_{noise}} \approx 10^3$

B The highest frequency in the signal should not exceed 24.0 kHz.

C The recommended number of bits per sample is 8.

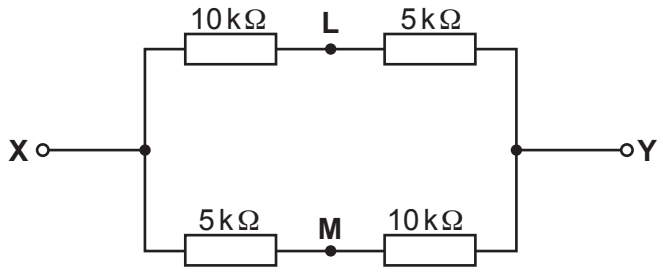
D The voltage resolution of the sampling should be about 1 mV.

Your answer ☐ **[1]**

Turn over for the next question

The following information is for use in questions **5** and **6**.

The diagram shows a combination of four resistors.



5 What is the resistance between **X** and **Y**?

A 5 kΩ

B 7.5 kΩ

C 15 kΩ

D 30 kΩ

Your answer ☐ **[1]**

6 A battery of e.m.f. 12 V and negligible internal resistance is connected across **X Y**.

What is the magnitude of the p.d. between **L** and **M**?

A 2 V

B 4 V

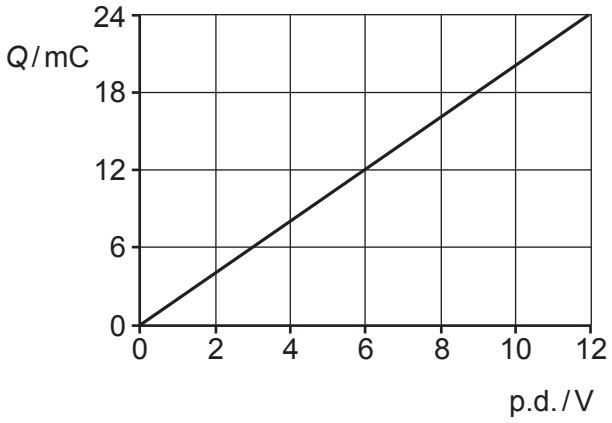
C 6 V

D 8 V

Your answer ☐ **[1]**

The following information is for use in questions **7** and **8**.

The diagram shows the $Q - V$ graph for a capacitor charged to 12 V.



7 What is the capacitance?

A 2×10^{-3} F

B 144×10^{-3} F

C 288×10^{-3} F

D 500 F

Your answer ☐ **[1]**

8 Which of the following is the energy stored?

A 2×10^{-3} J

B 144×10^{-3} J

C 288×10^{-3} J

D 500 J

Your answer ☐ **[1]**

9 Electrons accelerated through a potential difference V pass through a thin layer of graphite. The beam forms a diffraction pattern of rings on a fluorescent screen.
When V is made larger the diameter of the rings get smaller and they also become brighter.

Which **one** of the following statements about this experiment is correct?

A The power delivered to the fluorescent screen decreases as V increases.

B The diameter of the diffraction rings is independent of the interatomic spacings in graphite.

C The wavelength of the electrons decreases as their kinetic energy increases.

D The momentum of the electrons decreases as V increases.

Your answer ☐ **[1]**

10 Which **one** of the following statements about photons is correct?

The probability of arrival of a photon at a position

A is proportional to the amplitude of the waves arriving at that position.

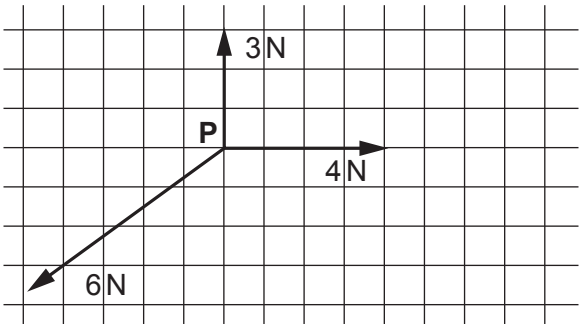
B is greater if the phasor amplitudes for paths from the source to that position "curl up" when they are added.

C is proportional to the (resultant phasor amplitude)^2 for all photon paths from the source to that position.

D is proportional to the phasor amplitude for the photon path straight from the source to that position.

Your answer ☐ **[1]**

11 The three forces in this vector diagram act in one plane on an object **P**.



What is the magnitude and direction of the resultant?

A 1 N ↙

B 1 N ↗

C 1 N →

D 11 N ↙

Your answer ☐ **[1]**

12 A car travelling at $10\,m\,s^{-1}$ is brought to rest in a braking distance of 10 m.

Using the same average braking force, in what distance can the car be brought to rest from a speed of $40\,m\,s^{-1}$?

A 20 m

B 40 m

C 80 m

D 160 m

Your answer ☐ **[1]**

13 The drag force F of the air on a train is

$$F \approx 10v^2$$

where F is in newtons and the speed v is in $\mathrm{m\,s^{-1}}$.

What **power** must be delivered by the engine to keep the train travelling at a constant $50\,\mathrm{m\,s^{-1}}$?

A 25 kW

B 125 kW

C 1.25 MW

D 2.5 MW

Your answer ☐ **[1]**

14 Suppose that a particular radioactive nucleus is observed for a period of time to find when it decays.
The isotope's half-life is 1 hour, and after 1 hour the particular nucleus has **not** decayed.

The chance that it will decay in the next second

A cannot be stated because the chance varies randomly from second to second.

B is now half the chance that it had to decay in the first second.

C is just the same as the chance that it would have decayed in the first second or any other second.

D is the same as the chance that it will not decay in the next second.

Your answer ☐ **[1]**

The following information is for use in questions **15** and **16**.

Two heater coils **X** and **Y** dissipate the same power when coil **X** runs at 12 V and coil **Y** runs at 6 V. The coils are made from equal lengths of wire of the same material, but different diameter.

15 Which one of **A** to **D** below is equal to the ratio $\frac{\text{resistance of } \mathbf{X}}{\text{resistance of } \mathbf{Y}}$?

A $\frac{1}{4}$

B $\frac{1}{2}$

C 2

D 4

Your answer ☐ **[1]**

16 Which one of **A** to **D** below is equal to the ratio $\frac{\text{diameter of wire } \mathbf{X}}{\text{diameter of wire } \mathbf{Y}}$?

A $\frac{1}{4}$

B $\frac{1}{2}$

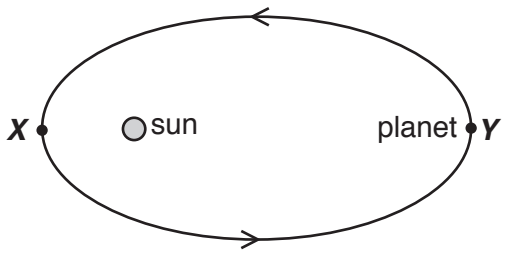
C 2

D 4

Your answer ☐ **[1]**

The following information is for use in questions **17** and **18**.

A planet is in elliptical orbit around the Sun as shown.



17 Which of the following is correct?

A As the planet leaves ***X*** it is speeding up.

B As the planet approaches ***X*** it is slowing down.

C As the planet approaches ***Y*** it is speeding up.

D As the planet leaves ***Y*** it is speeding up.

Your answer ☐ **[1]**

18 Which of the following quantities is **greater** at ***Y*** than at ***X***?

A the gravitational force on the planet from the sun

B the gravitational potential energy of the planet-sun system

C the kinetic energy of the planet in its orbit

D the total energy of the planet-sun system

Your answer ☐ **[1]**

19 Two samples **L** and **M** contain the same mass of an ideal gas.

In which of the following cases will it always be true that the molecules in **L** have a larger root mean square speed than those in **M**?

1 **L** is at a greater temperature than **M**

2 **L** has a greater volume than **M**

3 **L** is at a greater pressure than **M**

A 1, 2 and 3 are correct

B only 1 and 2 are correct

C only 2 and 3 are correct

D only 1 is correct

Your answer [ ] **[1]**

20 At 300 K a process has an activation energy $E = 10kT$.

The temperature is raised to 330 K.

Which statement about the rate of the process is correct?

It will increase by

A 10% because temperature has increased by 10%.

B 10% because the mean square speed of the particles has increased by 10%.

C 9.1 times because $\frac{E}{kT} = \frac{3000k}{330k} = 9.1$.

D 2.5 times because $e^{\frac{-E}{kT}}$ has increased by $\frac{e^{-9.1}}{e^{-10}} = 2.5$ times.

Your answer ☐ **[1]**

21 Which of the following changes doubles the flux in a magnetic circuit?

1 doubling the permeance

2 doubling the current-turns

3 halving the circuit length

A 1, 2 and 3 are correct

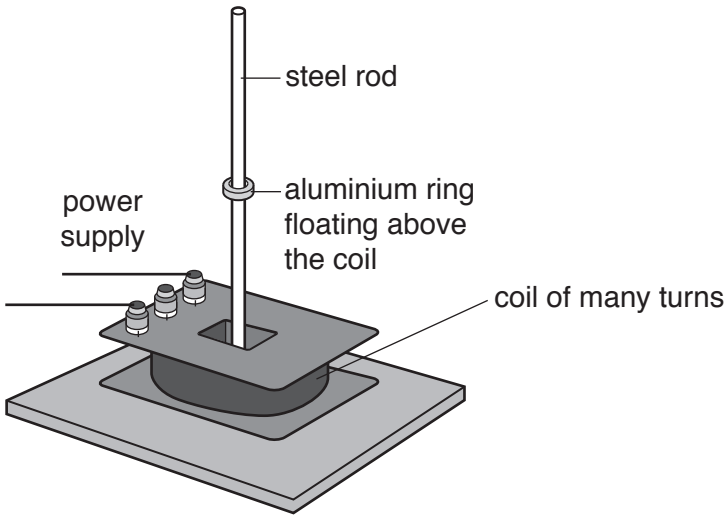
B only 1 and 2 are correct

C only 2 and 3 are correct

D only 1 is correct

Your answer ☐ **[1]**

22 An aluminium ring is free to move on a steel rod.
When the power supply is on, the ring floats.



Which of the following is correct?

A An a.c. or d.c. power supply can be used.

B The induced current in the ring is in the same direction as the current in the coil.

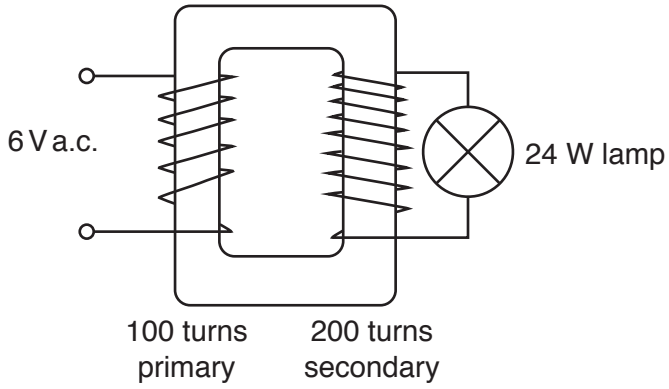
C The only purpose of the steel rod is to support the ring.

D When the ring is pushed down towards the coil more flux links it and the induced current increases.

Your answer ☐ **[1]**

The following information is for use in questions **23** and **24**.

A 6 V a.c. supply is connected to the 100 turn primary coil of an ideal transformer.
The 200 turn secondary coil runs a lamp which dissipates 24 W.



23 Which is the best estimate of the current in the secondary coil?

A $\frac{1}{4}$ A

B $\frac{1}{2}$ A

C 2 A

D 4 A

Your answer ☐ **[1]**

24 Which is the best estimate of the current in the primary coil?

A $\frac{1}{4}$ A

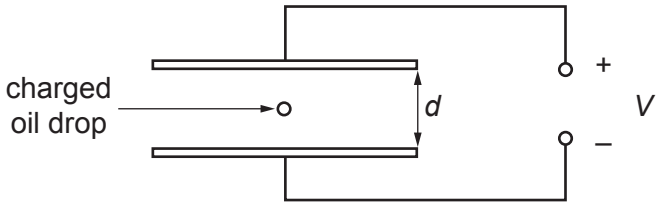
B $\frac{1}{2}$ A

C 2 A

D 4 A

Your answer ☐ **[1]**

25 An oil drop of mass m charged by one electron is balanced between two parallel horizontal metal plates. A potential difference V is applied between the plates as shown.



Which expression shows the balanced electrical and gravitational forces acting?

A $eVd = mg$

B $\frac{eV}{d} = mg$

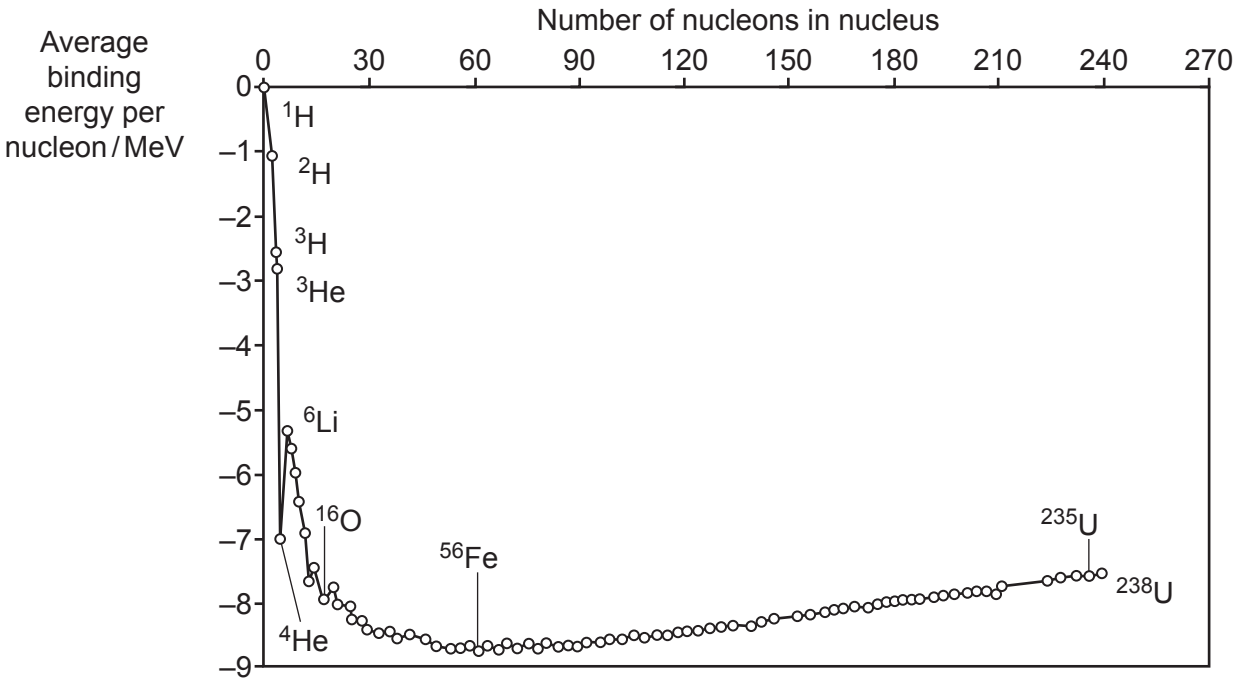
C $\frac{V}{ed} = mg$

D $\frac{dV}{e} = mg$

Your answer ☐ **[1]**

The following information is for use in questions **26** and **27**.

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



26 Which **one** of the following statements is correct?

A All unstable nuclei have less binding energy than stable nuclei.

B ^{56}Fe requires less energy per nucleon than other stable nuclei to pull it apart into individual nucleons.

C Binding energy can be released in the fission of some heavy elements

D Binding energy is the energy released when a nucleus breaks down into individual nucleons.

Your answer ☐ **[1]**

27 Which is the best estimate for the total binding energy for a nucleus of $^{16}_{8}O$ (Oxygen)?

A – 10 pJ

B – 20 pJ

C – 64 pJ

D – 128 pJ

Your answer ☐ **[1]**

28 Isotopes of a given element all have the same

A proton number.

B charge / mass ratio.

C neutron number.

D nucleon number.

Your answer ☐ **[1]**

29 Which of the following statements about the α-particle and the β-particle is correct?

A If both have the same kinetic energy, the speed of the β-particle is less than that of the α-particle.

B If both have the same momentum, the de Broglie wavelength of the α-particle must be the same as that of the β-particle.

C If both have the same momentum, the kinetic energy of the α-particle is greater than that of the β-particle.

D The rest energies of both the α-particle and the β-particle are the same.

Your answer ☐ **[1]**

30 $^{214}_{82}Pb$ decays by a series of transformations to a final stable product.

The particles emitted are: β, β, α, β, β, α.

Which one of the isotopes below is the final product?

A $^{206}_{82}Pb$

B $^{210}_{82}Pb$

C $^{208}_{83}Bi$

D $^{214}_{83}Bi$

Your answer ☐ **[1]**

Answers to MC Booklet

Year 1 (AS) Content Questions are in Blue

	H157 Sample	H157 Practice 1	H157 2016	H557 Sample	H557 Practice 1	H557 Practice 2	H557 2017
1	B	A	A	C	B	D	D
2	D	D	B	D	D	B	B
3	C	C	B	D	C	C	A
4	C	B	D	D	A	D	A
5	C	A	A	C	D	D	B
6	C	D	C	D	B	D	B
7	B	B	C	C	D	A	A
8	A	A	B	A	D	C	B
9	A	B	A	B	A	B	C
10	C	C	C	A	C	B	C
11	C	A	C	C	B	D	A
12	D	C	B	B	C	D	D
13	A	C	B	C	D	A	C
14	C	C	C	D	A	B	C
15	B	A	D	D	C	B	D
16	D	C	A	C	B	D	B
17	D	D	C	C	C	D	D
18	B	D	A	D	D	B	B
19	D	D	B	C	A	C	D
20	A	C	C	B	C	C	D
21				C	C	D	A
22				C	D	D	D
23				B	C	B	C
24				C	B	B	D
25				B	A	D	B
26				A	B	B	C
27				B	B	C	B
28				C	B	A	A
29				B	C	B	B
30				C	D	C	A