

Physics

Advanced Subsidiary

Paper 1: Core Physics 1

Total Marks

Tuesday 12 May 2020 – Morning

Time: 1 hour 30 minutes plus your additional time allowance

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

Scientific calculator, Ruler

YOU WILL BE GIVEN

Data, Formulae and Relationships Booklet

Diagram Booklet

INSTRUCTIONS

Answer ALL questions in Section A and B.

Answer the questions in the spaces provided – there may be more space than you need.

INFORMATION

The total mark for this paper is 80.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

In questions marked with an ASTERISK (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or how they follow on from each other where appropriate.

The list of data, formulae and relationships is provided.

ADVICE

Read each question carefully before you start to answer it.

Try to answer every question.

Check your answers if you have time at the end.

You are advised to show your working in calculations including units where appropriate.

SECTION A

Answer ALL questions. Write your answers in the spaces provided.

All multiple choice questions must be answered with a cross ☒ in the box for the correct answer from A to D. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 A student wanted to measure the thickness of a single sheet of aluminium foil.**

Which of the following instruments would be the most appropriate to make this measurement?

- ☐ **A measuring tape**
- ☐ **B micrometer screw gauge**
- ☐ **C ruler**
- ☐ **D vernier calipers**

(TOTAL FOR QUESTION 1 = 1 MARK)

- 2 Look at the diagram for Question 2 in the Diagram Booklet. An object of mass m is moved from the bottom to the top of a slope. The vertical height of the slope is y .

The horizontal distance between the bottom and top of the slope is x .

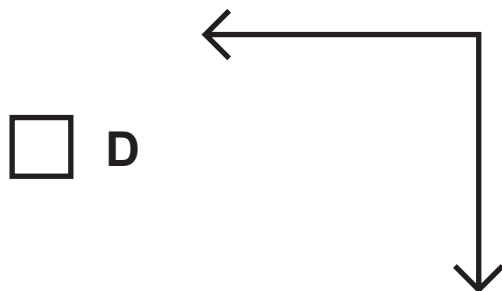
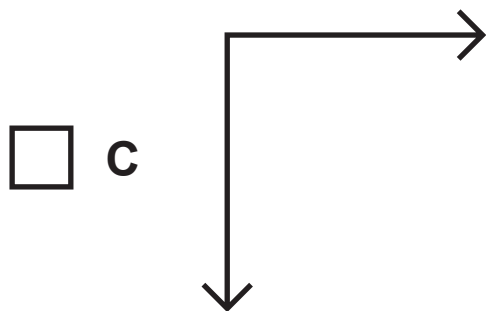
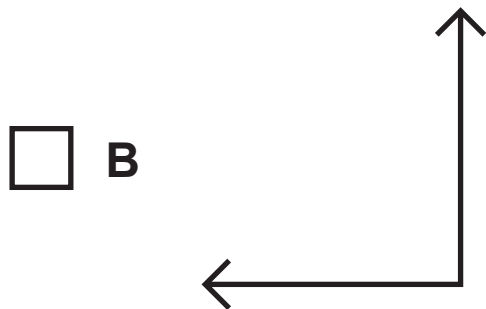
Which of the following gives the gain of gravitational potential energy of the object as it moves from the bottom to the top of the slope?

- ☐ A mgx
- ☐ B $mg y$
- ☐ C $mg(x + y)$
- ☐ D $mg\sqrt{(x^2 + y^2)}$

(TOTAL FOR QUESTION 2 = 1 MARK)

- 3 Look at the diagram for Question 3 in the Diagram Booklet. A suitcase is being dragged along the ground by the handle in the direction shown.

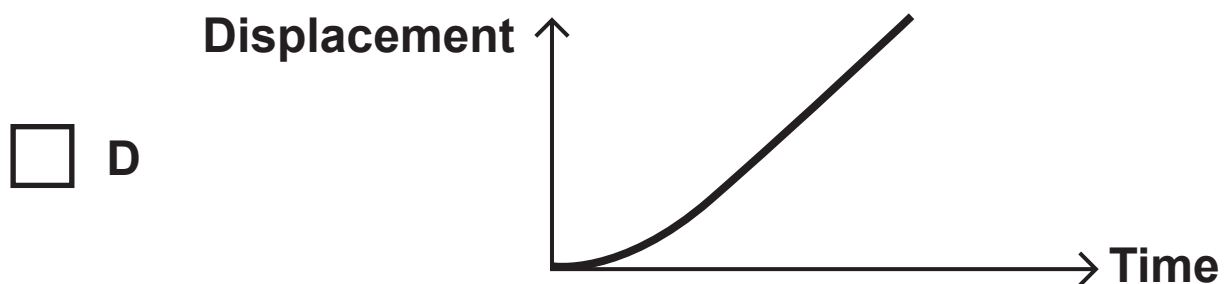
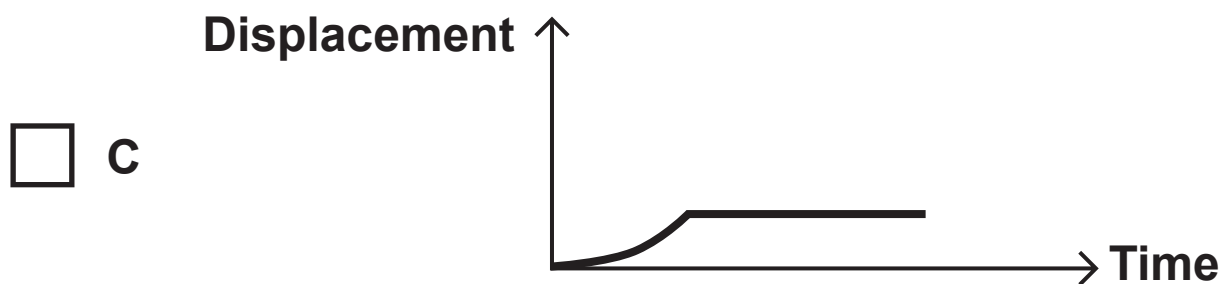
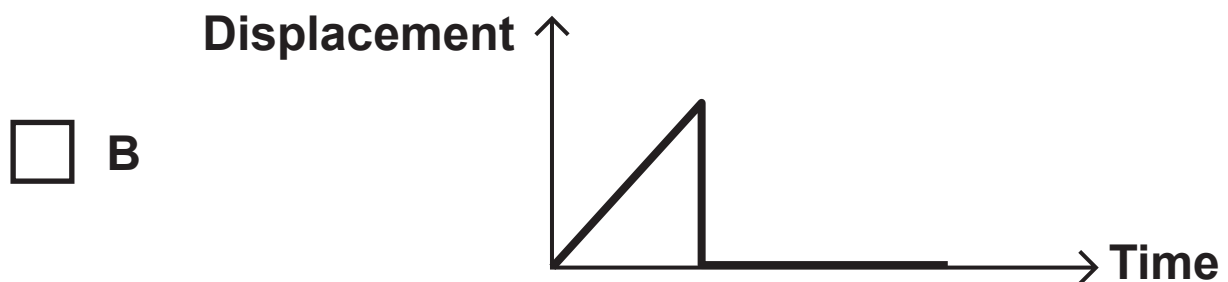
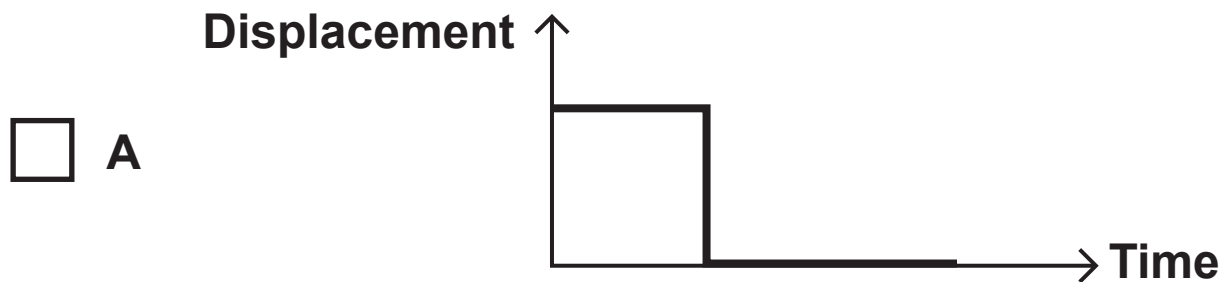
Which of the following shows the direction of the horizontal and vertical components of force acting on the ground due to the suitcase?



(TOTAL FOR QUESTION 3 = 1 MARK)

- 4 Look at the graph for Question 4 in the Diagram Booklet. The graph shows how the velocity varies with time for an object.

Which of the following graphs shows how the displacement varies with time for this object?



(TOTAL FOR QUESTION 4 = 1 MARK)

5 Which of the following is a vector quantity?

☐ A kinetic energy

☐ B momentum

☐ C time

☐ D work done

(TOTAL FOR QUESTION 5 = 1 MARK)

6 Which of the following gives the S.I. base units equivalent to the volt?

☐ A J C^{-1}

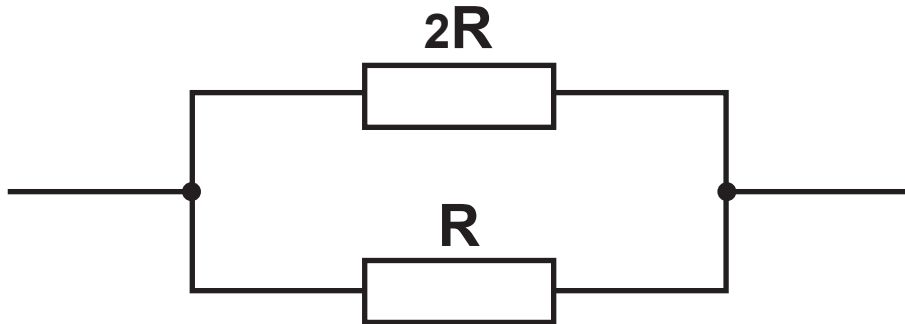
☐ B $\text{J A}^{-1} \text{s}^{-1}$

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

☐ D $\text{kg m}^2 \text{s}^{-3} \text{A}^{-1}$

(TOTAL FOR QUESTION 6 = 1 MARK)

- 7 Part of an electric circuit consists of two resistors. One resistor has a resistance $2R$ and the other resistor has a resistance R as shown.



Which of the following is the equivalent resistance of this combination?

- ☐ A $\frac{R}{3}$
- ☐ B $\frac{2R}{3}$
- ☐ C $\frac{3R}{2}$
- ☐ D $3R$

(TOTAL FOR QUESTION 7 = 1 MARK)

- 8 Look at the graph for Question 8 in the Diagram Booklet. The graph shows the variation of current I with potential difference V for a diode.

Which of the following statements is correct?

- ☐ A The diode has zero resistance when connected in the forward direction.
- ☐ B The diode has zero resistance when connected in the reverse direction.
- ☐ C The diode starts to conduct when the potential difference is about 0.7 V .
- ☐ D The diode stops conducting when the potential difference is about -0.7 V .

(TOTAL FOR QUESTION 8 = 1 MARK)

- 9 A vehicle that skids can leave a mark on the road surface. This skid mark can be used to calculate the velocity of the vehicle at the start of the skid.

At a test track a car of mass 1500 kg was collided into the back of a stationary car of mass 1200 kg. The two cars skidded along the road together, leaving skid marks of length 7.5 m. The cars decelerated at 5.6 m s^{-2} to a stop at the end of the skid.

- (a) Show that the velocity of the two cars at the start of the skid was about 9 m s^{-1} . (3 marks)

(continued on the next page)

9 continued.

(b) Calculate the velocity with which the car of mass 1500 kg collided with the stationary car. (3 marks)

Velocity = _____

(continued on the next page)

9 continued.

- (c) In practice, the velocity of the car is not exactly the same as that calculated in (b).**

Explain why. (2 marks)

(TOTAL FOR QUESTION 9 = 8 MARKS)

10 Look at the diagram for Question 10 in the Diagram Booklet. In a 'balancing birds' puzzle, model owls and crows are each placed in one of six equally spaced positions marked on a perch. The perch has negligible mass, and is suspended from another of the six marked positions. With the birds placed, and the perch suspended, as shown, the puzzle is in equilibrium.

(a) State what is meant by 'in equilibrium'. (2 marks)

(continued on the next page)

10 continued.

- (b) (i) The owl has a mass $2M$ and the crow has a mass M . Show that the perch will balance when suspended as shown from position X. (1 mark)**

(continued on the next page)

10 continued.

- (ii) Look at the diagram for Question 10(b)(ii) in the Diagram Booklet. The perch is then attached to a second perch and suspended as shown. Two more birds, not shown, are placed at A and B, and the whole arrangement is in equilibrium. Each crow has the same mass M . The mass of an owl is $2M$.**

Explain, with the aid of a calculation, which type of bird sits at A and which type of bird sits at B to ensure the whole arrangement is in equilibrium. (3 marks)

(continued on the next page)

Turn over

10 continued.

(TOTAL FOR QUESTION 10 = 6 MARKS)

- 11** Look at the spreadsheet for Question 11 in the Diagram Booklet. A student modelled the behaviour of a circuit containing a cell of emf 1.5 V with internal resistance $3.0\ \Omega$, using a spreadsheet. In this model the cell is connected across a resistor. The student used the model to investigate how the power P dissipated by the resistor varies with its resistance R .

(a) Show how the value in B2 is calculated. (1 mark)

(b) Show how the value in C5 is calculated. (1 mark)

(continued on the next page)

11 continued.

- (c) The student concluded that the power dissipated by the resistor is a maximum when R is between 2.5Ω and 3.5Ω .**

Explain how this spreadsheet could be improved so that this maximum can be located more precisely. (2 marks)

(TOTAL FOR QUESTION 11 = 4 MARKS)

12 A student wants to investigate how the resistance R of a negative temperature coefficient thermistor varies with its temperature T .

- (a) Write a set of instructions that the student could follow and include one safety precaution.
(6 marks)**

(continued on the next page)

12 continued.

(continued on the next page)

12 continued.

- (b) Look at the graph for Question 12(b) in the Diagram Booklet. The graph was plotted from the results of another student's experiment for the same topic.**

**Give two modifications to the experimental procedure that could improve these results.
(2 marks)**

(continued on the next page)

12 continued.

(c) Explain, in terms of particle behaviour, why the resistance of the thermistor decreases as temperature increases. (4 marks)

[illegible]

(TOTAL FOR QUESTION 12 = 12 MARKS)

Turn over

- 13 A website advertises an electric car with the following information.**

EFFICIENCY 195Wh / km

USEABLE BATTERY CAPACITY 22kWh

BATTERY CHARGING POWER 3.6kW

CHARGING TIME 7 HOURS

RANGE 129 km

- (a) State why the 'efficiency' given on the website cannot be a value of efficiency as defined in physics. (1 mark)**

(continued on the next page)

13 continued.

(b) Explain why the kilowatt-hour (kWh) is a unit of energy. (2 marks)

(continued on the next page)

13 continued.

(c) Calculate the efficiency of the battery. (3 marks)

Efficiency = _____

(continued on the next page)

13 continued.

- (d) A comparable petrol car has a petrol consumption of 21 km / litre.**

**Show that the electric car is cheaper to run.
(2 marks)**

cost of 1 litre of petrol = £1.20

cost of 1 kWh of electricity = 13p

(continued on the next page)

Turn over

13 continued.

(e) Give one environmental advantage of an electric car. (1 mark)

(continued on the next page)

13 continued.

- (f) The website provides the following additional information.**

Maximum Engine Power 80 kW

Maximum Performance 0 to 28 ms^{-1} in 11.5 s

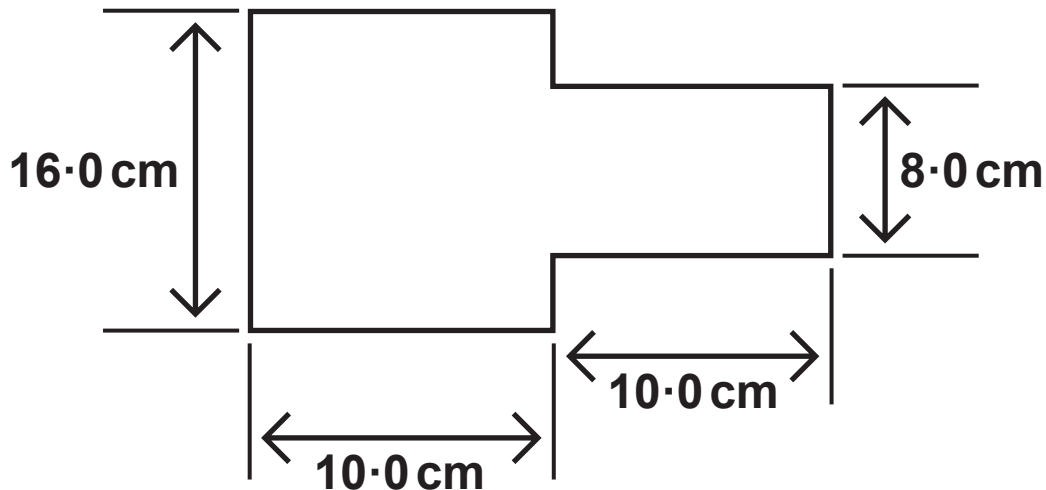
Mass of Car 1500 kg

Deduce whether the power of the engine is capable of producing this performance. (3 marks)

(TOTAL FOR QUESTION 13 = 12 MARKS)

Turn over

- 14 Carbon paper is an electrically conducting paper. A student cut a sheet of this paper into the shape shown below, to carry out an investigation.**



The student followed the procedure below to set up a potential divider circuit:

- connect the 16 cm and 8 cm wide ends to a 1.5V cell
- connect the 16 cm wide end to the negative (0V) terminal of the cell
- connect a voltmeter so that it measures the potential at a point 15 cm from the 16 cm wide end.

- (a) Using the diagram for Question 14(a) in the Diagram Booklet, add a circuit diagram to the diagram to show how the carbon paper is connected. (2 marks)**

(continued on the next page)

14 continued.

- *(b) Look at the graph for Question 14(b) in the Diagram Booklet. The graph was plotted from an investigation in which the potential was measured at various distances from the 16·0 cm wide end of the shape.**

Explain the shape of this graph. (6 marks)

(continued on the next page)

Turn over

14 continued.

[illegible]

(TOTAL FOR QUESTION 14 = 8 MARKS)

TOTAL FOR SECTION A = 58 MARKS

Turn over

SECTION B

Answer ALL questions.

- 15** Look at the diagram for Question 15 in the Diagram Booklet. The arrangement shown was used to determine the wavelength of light emitted by a laser.

A laser light beam was shone at a diffraction grating. A series of dots of light was produced on a screen. The angles θ between the light ray to the central dot and the light rays to the dots labelled 1 to 4 were measured with a protractor.

n	$\theta / ^\circ$	$\sin\theta$
1	12	0.21
2	23	0.39
3	34	0.56
4	51	0.78

(continued on the next page)

15 continued.

- (a) Describe how the angle θ could be determined without using a protractor. (2 marks)**

- (b) Using the grid for Question 15(b) in the Diagram Booklet, plot a graph of n against $\sin\theta$. (4 marks)**

(continued on the next page)

15 continued.

(c) The diffraction grating has $300 \text{ lines mm}^{-1}$.

**Determine the wavelength of the laser light.
(4 marks)**

(continued on the next page)

Turn over

15 continued.

Wavelength = _____

(TOTAL FOR QUESTION 15 = 10 MARKS)

16 Look at the graph for Question 16 in the Diagram Booklet. In a game of badminton, a shuttlecock is hit by a racket. The graph shows how the vertical displacement (y) and horizontal displacement (x) of the shuttlecock vary from the moment it leaves the racket. The positions are recorded every 0.10 s.

(a) Look at the graph for Question 16(a) in the Diagram Booklet. The graph shows how the velocity of the shuttlecock in the vertical direction varies with time.

(i) Explain how the velocities have been calculated from the successive vertical positions of the shuttlecock. (2 marks)

(continued on the next page)

16 continued.

- (ii) State why these velocities have been plotted at the mid-range of the time interval. (1 mark)**

(continued on the next page)

16 continued.

- (iii) State, with a reason, two pieces of evidence from the graphs that show that the shuttlecock does NOT follow the motion of a projectile moving freely under gravity. (3 marks)**

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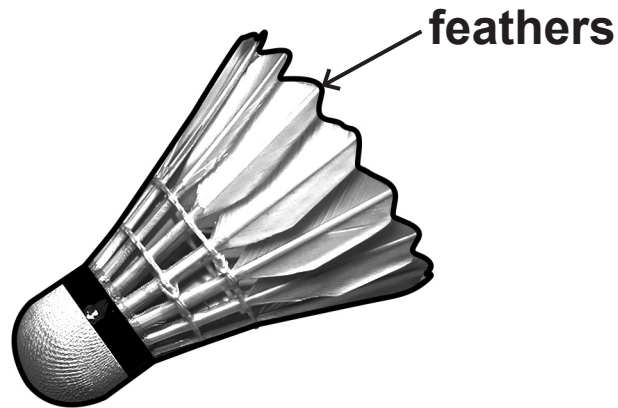
16 continued.

- (iv) Show, using the velocity-time graph, that the maximum height gained by the shuttlecock is about 3 m. (3 marks)**

(continued on the next page)

16 continued.

(b) The photograph shows a shuttlecock.



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The shuttlecock always moves through the air with the 'feathers' trailing behind.

Explain how the feathers affect the motion of the shuttlecock along its path. (3 marks)

(continued on the next page)

Turn over

16 continued.

(TOTAL FOR QUESTION 16 = 12 MARKS)

TOTAL FOR SECTION B = 22 MARKS
TOTAL FOR PAPER = 80 MARKS
END