Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	7	3	1	/	0	1	Signature	

Paper Reference(s)

6731/01

Edexcel GCE

Physics

Advanced Subsidiary

Unit Test PHY1

Wednesday 16 January 2008 – Afternoon

Time: 1 hour 15 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
Total	

Materials required for examination
Nil

Items included with question papers
Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your signature, your surname and initial(s).
Answer **ALL** questions in the spaces provided in this question paper.
In calculations you should show all the steps in your working, giving your answer at each stage.
Calculators may be used.
Include diagrams in your answers where these are helpful.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets.
There are eight questions in this paper. The total mark for this paper is 60.
The list of data, formulae and relationships is printed at the end of this booklet.

Advice to Candidates

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

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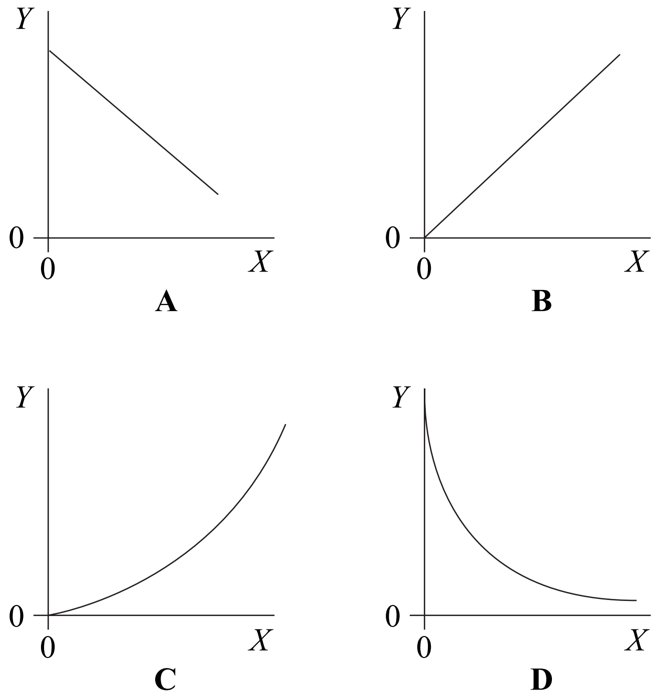
1. Each of the following graphs shows how a physical quantity Y varies with a physical quantity X.



Complete the following table to indicate which of these graphs could best describe the relationships given. You may use each graph once, more than once or not at all.

Quantity Y	Quantity X	Graph
The moment of a force about a pivot.	The perpendicular distance of the line of action of the force from the pivot.	
The resultant force applied to a body.	The product of the body's mass and acceleration.	
The vertical distance an object falls from rest in frictionless conditions.	The speed it attains.	
The activity of a radioisotope.	The number of atoms that have decayed.	

Q1

(Total 4 marks)

Leave blank

2. (a) State the principle of moments.

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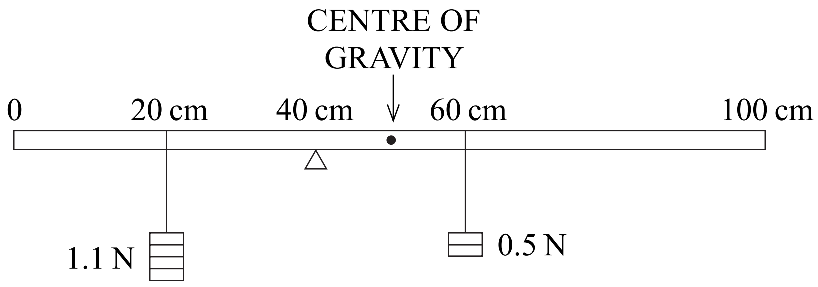
(2)

(b) A student balances a metre rule on a pivot using weights of 0.5 N and 1.1 N as shown in the diagram. The centre of gravity of the rule is at 50 cm.



(i) Calculate the weight of the rule.

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Weight = ...
(3)

(ii) The student now moves the pivot to the centre of gravity of the rule, but does not change the position of the weights.

Calculate the additional weight that must be added to the 0.5 N weight for the rule to balance.

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Additional weight = ...
(3)

Q2

(Total 8 marks)

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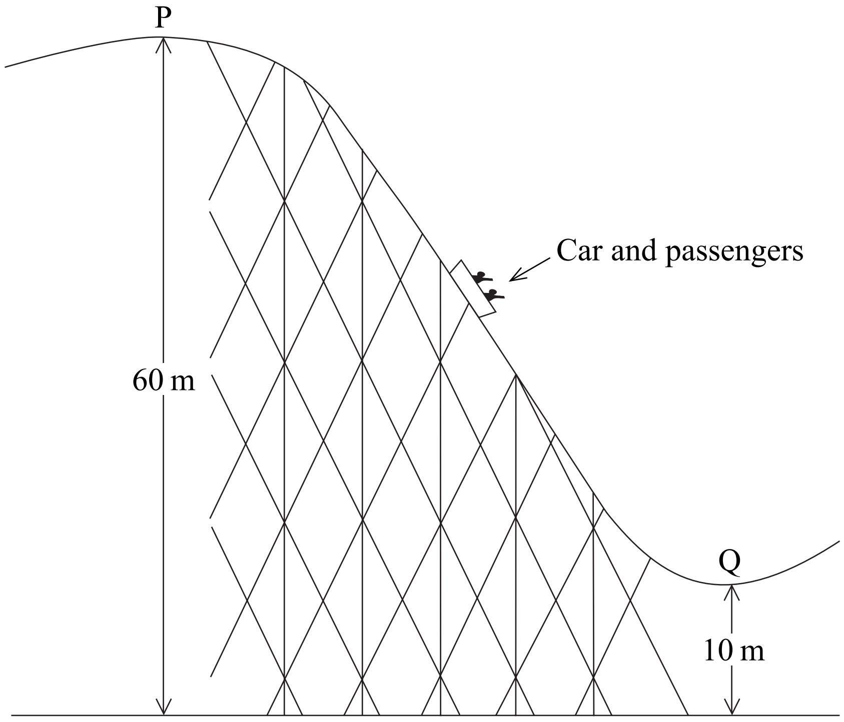
3. The diagram shows part of a rollercoaster ride. The car begins its descent at P where it has negligible speed. It reaches maximum speed at Q.



(a) If there were no forces opposing its motion, show that the speed of the car at Q would be approximately 30 m s^{-1}.

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(3)

Leave blank

(b) A braking system is used to prevent the car travelling faster than 27 m s^{-1}.

(i) The car and passengers shown in the diagram have a total mass of 750 kg. The length of track from P to Q is 80 m. Calculate the average braking force that would be required if the speed of the car is to be limited to 27 m s^{-1}.

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Braking force = ...

(3)

(ii) In practice, the braking system would not have to produce this magnitude of force. Suggest why.

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(1)

(iii) Explain whether the braking force would have to change if the car was carrying a heavier load of passengers. You may be awarded a mark for the clarity of your answer.

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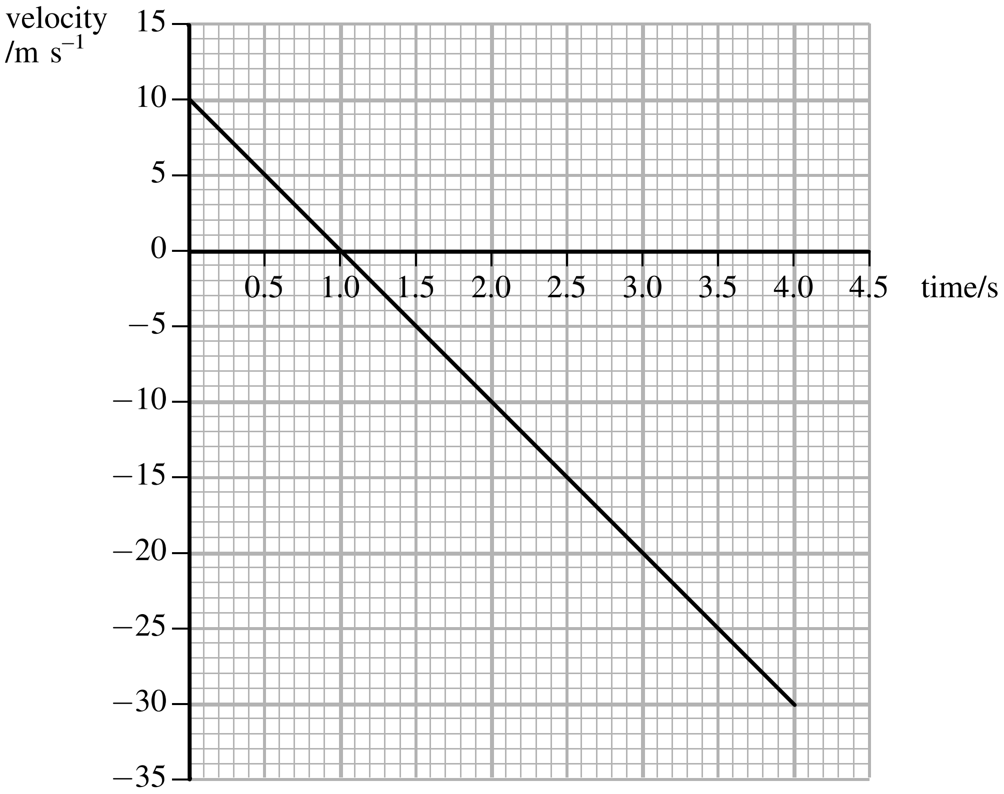
(4)

Q3

(Total 11 marks)

4. A hot-air balloon is rising vertically at a speed of $10\ \text{m s}^{-1}$. An object is released from the balloon. The graph shows how the velocity of the object varies with time from when it leaves the balloon to when it reaches the ground four seconds later. It is assumed that the air resistance is negligible.



(a) Use the graph to

(i) show that the object continues to rise for a further 5 m after it is released.

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(1)

(ii) determine the total distance travelled by the object from when it is released from the balloon to when it reaches the ground.

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Total distance = ...
(2)

Leave blank

N 2 1 0 6 6 A 0 6 1 6

(b) Hence determine the object's final displacement from its point of release from the balloon.

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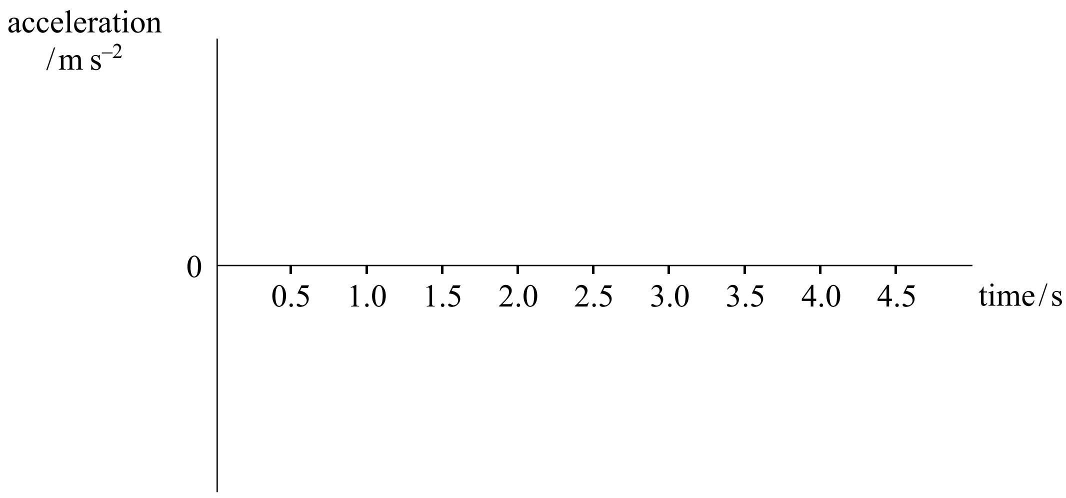
Displacement = ...

(2)

(c) Using the axes below, sketch a graph showing how the acceleration of the object changes during the time from when it leaves the balloon to when it hits the ground. Mark any significant values on the axes.



(3)

Q4

(Total 8 marks)

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5. A flea jumps vertically from a surface. It does this by rapidly extending its legs so that it experiences an upward force. Figure 1 shows the flea before it begins its jump. Figure 2 shows the flea the moment its legs are fully extended and about to leave the surface.

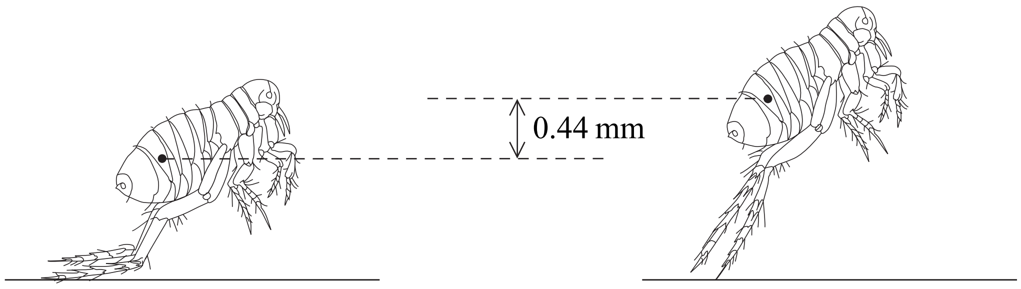

Figure 1 **Figure 2**

(a) Explain how Newton's third law accounts for the upward force produced.

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(2)

(b) (i) At the moment the flea's legs leave the surface its body is raised 0.44 mm and it is moving at a speed of 0.95 m s^{-1}. Show that the average acceleration of the flea during take-off is about 1000 m s^{-2}.

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(3)

(ii) The mass of the flea is 4.0×10^{-7} kg. Calculate the resultant vertical force acting on the flea.

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Resultant vertical force = ...
(1)

Leave blank

(c) (i) What constant force opposes the upward motion of the flea?

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(1)

(ii) Air resistance also opposes the motion of the flea. At the instant the flea's legs leave the surface it is travelling at $0.95\ \text{m s}^{-1}$. It takes a further 9.3×10^{-2} s to reach its maximum height. Calculate the change in height it achieves during this time. Assume its deceleration is constant.

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Change in height = ...

(3)

Q5

(Total 10 marks)

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6. A uranium-238 nucleus, decays to a thorium-234 nucleus according to the nuclear equation

$$^{238}_{92}U \rightarrow \, ^{234}_{90}Th + \text{particle}$$

(a) Identify the particle.

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(1)

(b) The particle is emitted with a speed of 1.41×10^7 m s^{-1} and a kinetic energy of 6.58×10^{-13} J. Use this data to show that the momentum of the particle at the instant it is emitted is about 9×10^{-20} kg m s^{-1}.

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(4)

(c) When a decaying uranium-238 nucleus is at rest, the thorium-234 nucleus moves with a speed of 2.4×10^5 m s^{-1} in the opposite direction to the particle.

Explain with the aid of a calculation how this is consistent with the principle of conservation of momentum.

Mass of thorium-234 nucleus = 3.89×10^{-25} kg

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(3)

Q6

(Total 8 marks)

Leave blank

7. (a) The ratio $\frac{\text{radius of atom}}{\text{radius of nucleus}}$ for a given atom is about 10^5.

Use this value to calculate the ratio $\frac{\text{density of atom}}{\text{density of nucleus}}$.

State the assumption you have made.

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Assumption ....

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(4)

(b) What observation is made in the alpha particle scattering experiment that supports your assumption?

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(1)

Q7

(Total 5 marks)

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8. As a beta-minus particle travels through air it causes ionisation.

(a) Describe how the beta particle produces ionisation.

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(1)

(b) Explain how the amount of ionisation determines a beta particle's range in air.

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(3)

(c) Explain why, towards the end of its range, a beta particle will ionise more molecules per unit length than at the beginning of its range.

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(2) **Q8**

(Total 6 marks)

TOTAL FOR PAPER: 60 MARKS

END

List of data, formulae and relationships

Data

Speed of light in vacuum	$c = 3.00 \times 10^8\ \text{m s}^{-1}$	
Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to the Earth)
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to the Earth)

Rectilinear motion

For uniformly accelerated motion:

$$v = u + at$$

$$x = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2ax$$

Forces and moments

Moment of F about O = $F \times$ (Perpendicular distance from F to O)

Sum of clockwise moments about any point in a plane = Sum of anticlockwise moments about that point

Dynamics

Force $\quad F = m\dfrac{\Delta v}{\Delta t} = \dfrac{\Delta p}{\Delta t}$

Impulse $\quad F\Delta t = \Delta p$

Mechanical energy

Power $\quad P = Fv$

Radioactive decay and the nuclear atom

Activity $\quad A = \lambda N \quad$ (Decay constant λ)

Half-life $\quad \lambda t_{\frac{1}{2}} = 0.69$

Experimental physics

$$\text{Percentage uncertainty} = \frac{\text{Estimated uncertainty} \times 100\%}{\text{Average value}}$$

Mathematics

$$\sin(90° - \theta) = \cos\theta$$

Equation of a straight line $\quad y = mx + c$

Surface area $\quad \text{cylinder} = 2\pi rh + 2\pi r^2$

$\quad \text{sphere} = 4\pi r^2$

Volume $\quad \text{cylinder} = \pi r^2 h$

$\quad \text{sphere} = \tfrac{4}{3}\pi r^3$

For small angles: $\quad \sin\theta \approx \tan\theta \approx \theta \quad$ (in radians)

$\quad \cos\theta \approx 1$

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