Name: ………………………………………………………….
(First name *and* surname - CAPITAL LETTERS please)

Current school: ………………………………………………………

St Paul's School
FOUNDED 1509

16+ Entry Examination

SAMPLE PAPER

Physics

45 Minutes

Instructions to Candidates

- Write your name in the space at the top of this page.
- Answer all of the questions.
- Write your answers in the spaces provided on the question paper.

Information for Candidates

- The number of marks available is shown in brackets [ ] at the end of each question or part question. The total mark for the paper is 41.
- The marks allocated and the spaces provided for your answers are a good indication of the length of answer required.
- Please show all of your working clearly.

You may use a calculator

In calculations ignore air resistance and take g=10 m/s²

You may find the following formulae helpful

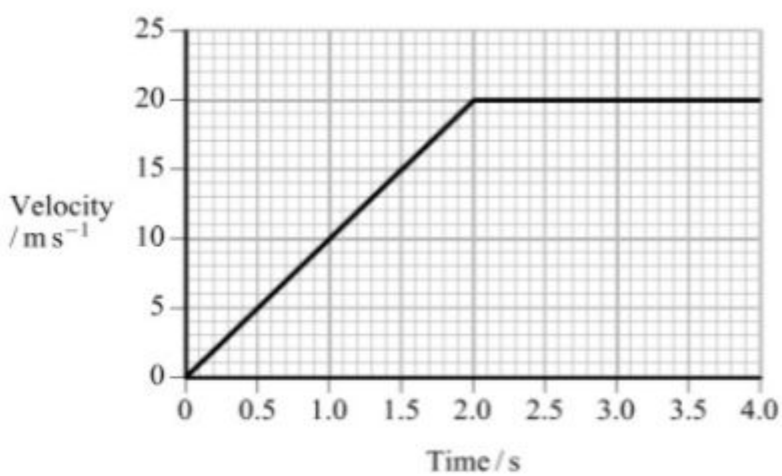
1. $s = \frac{u+v}{2} \times t$ *(average velocity x time)*
2. $v = u + a \times t$ *(initial velocity + acceleration x time for acceleration)*
3. $v^2 = u^2 + 2 \times a \times s$
4. $s = u \times t + \frac{1}{2} a \times t^2$

Part A: Multiple Choice Questions: 8 questions : 16 Marks

Circle the correct answer. You may write on the paper to do calculations.

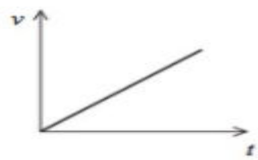
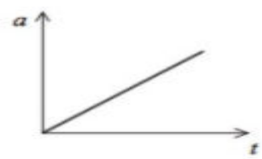
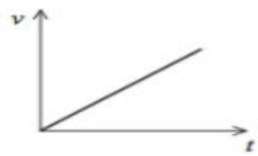
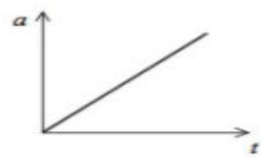
1. An object experiences a positive constant acceleration of 3 m/s^2 this means:
   a. The distance to the origin increases by 3m every second.
   b. The velocity of the object is constant.
   c. The acceleration of the object increases by 3 m/s^2 every second.
   d. The velocity of the object increases by 3 m/s every second.
   e. A displacement versus time graph would be a straight line.

2. The graph shows how the velocity varies for an object. After 3.0 seconds the distance travelled is:

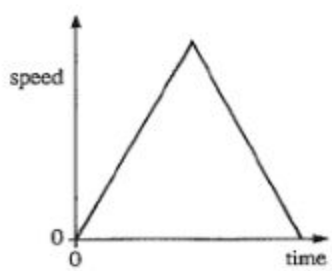


   a. 80 m
   b. 40 m
   c. 30 m
   d. 50 m
   e. 60 m

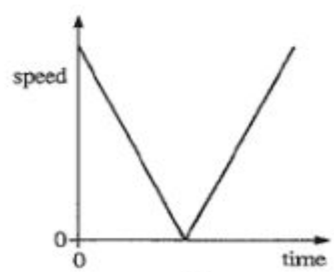
3. Which pair of graphs could be consistent for the motion of any object:

	Velocity-time graph	Acceleration-time graph
☒ A		
☒ B		
☒ C		
☒ D		

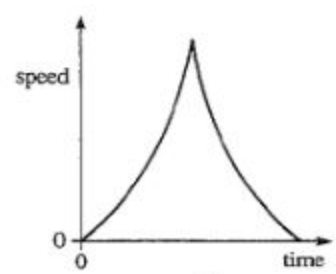
4. A ball is thrown up and then caught. Which graph best describes its motion:



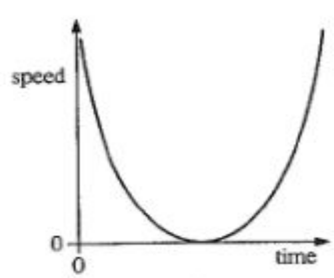
A



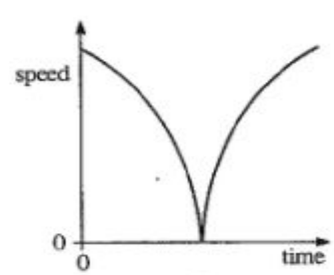
B



C



D

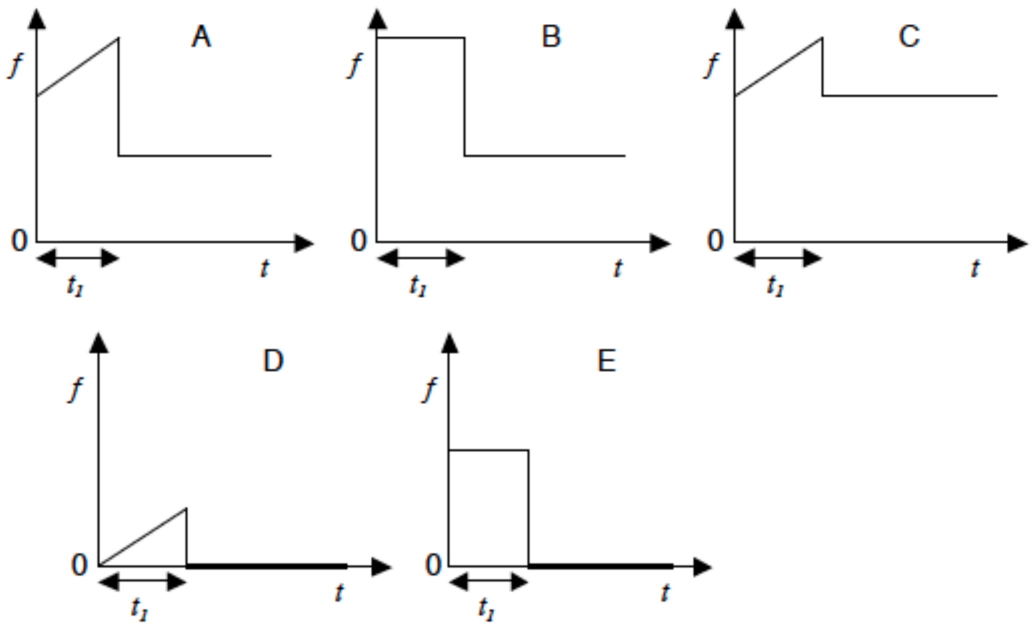


E

5. A slide in a fairground has a very steep initial slope, which gradually curves into a more gentle slope. If a child drops down the slide what happens to their speed **v** and magnitude of their acceleration **a**.
    a. ***v*** and ***a*** both increase.
    b. ***v*** increases and ***a*** stays the same.
    c. ***v*** increases and ***a*** decreases.
    d. ***v*** decreases and ***a*** increases.
    e. ***v*** increases and then decreases as ***a*** decreases.

6. A ball is dropped vertically from the top of the Shard (the tallest building in London) at 310 m. How long will it take to hit the ground:
    a. 2.5 s
    b. 5.0 s
    c. 7.5 s
    d. 10.0 s
    e. 12.5 s

7. The speed v of a vehicle travelling along a straight level road is shown below. It starts from rest at time t = 0, accelerates uniformly until t = t_1 and then continues at constant speed. At all times the vehicle experiences a retarding force due to friction, which is proportional to its speed. The force f, which must be applied by the engine of the vehicle, is given by:



8. The intelligent gerbils of Rodentland measure force in Gerbils and length in Tails where 1 Gerbil = 0.4 N and 1 Tail = 5 cm. What would their value be for atmospheric pressure of 100 kPa:
   a. 625 Gerbil / $Tail^2$
   b. 125 Gerbil / $Tail^2$
   c. 25 Gerbil / $Tail^2$
   d. 1.25 Gerbil / $Tail^2$
   e. 1 Gerbil / $Tail^2$

<u>Part B: Structured Response Question, 25 Marks</u>

A ball of mass 0.1kg bounces between the floor and ceiling of a room 1m high. Each time the ball hits the ***floor or the ceiling*** it loses 20% of its kinetic energy and rebounds. There is no air resistance in the room.

You will need the following equations, where it has been assumed the gravitational field strength, g=10N/kg

Kinetic energy = ½ x mass x $(\text{speed})^2$

Gravitational potential energy = mass x 10 x change in height

a) State the law of conservation of energy

[1]

b) As the ball travels downwards, what change in energy transfer is taking place?

Answer: Energy change is from ________________ to ________________ [2]

c) If the ball is dropped from 0.5m height, it will have only 80% (or 0.8 times) its initial gpe when it next gets to the top of the bounce: how high will it rebound? Show all your working.

[3]

d) The ball is thrown down from 0.5m height with an initial speed of 10m/s. Show that its initial kinetic energy is 5 J

[2]

e) Just before the ball hits the ground its total energy will be 5.5 J. Hence show that the ball will reach the ground with a speed of around 10.5 m/s

[3]

f) Since the initial kinetic energy of this ball is 5J, why is it not true that the ball stops after it has transferred 5 J of energy to the floor and ceiling of the room?

[1]

g) What form does the initial energy of the ball ultimately transfer to?

[1]

h) Since the room is 1 m high and by considering the energy changes that occur to the ball after it bounces off the floor, travels to the ceiling, bounces on the ceiling, and returns to the floor again show that the new kinetic energy ($E_{k\text{-}new}$ in Joules) just before any bounce from the ground can be calculated from the kinetic energy just before the previous bounce (when the ball has $E_{k\text{-}previous}$ in Joules) by the following formula:

$$E_{k\text{-}new} = 0.64 x E_{k\text{-}previous} + 0.2$$

[3]

i) Use this formula to complete the following table for each successive trip from the floor to the ceiling and back

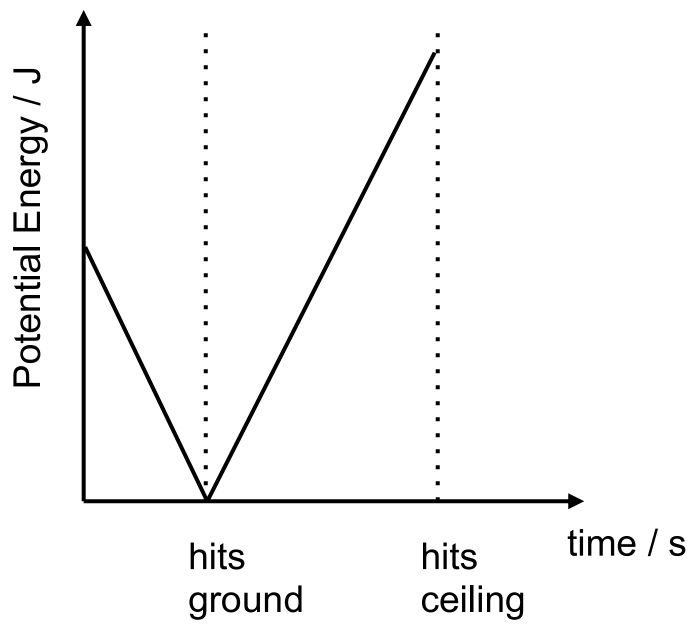
Number of bounces off the ceiling	Previous Kinetic Energy before hitting the floor ($E_{k\_previous}$) / J to 2sf	New kinetic Energy before next bounce from floor having hit ceiling (E_{k_new}) / J to 2sf
0	5.5	3.7
1	3.7	2.6
2	2.6	?
3	?	?
4	?	?
5	?	?

[4]

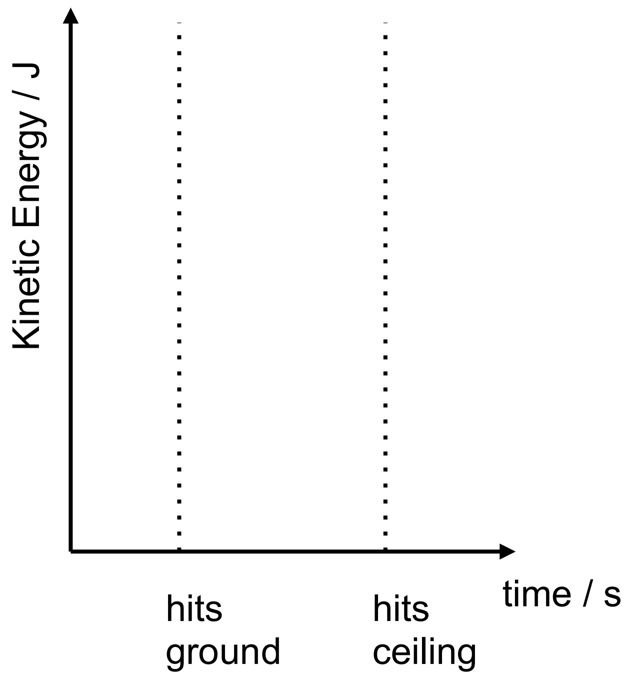
j) How many times will the ball hit the ceiling before it has insufficient energy to bounce high enough?

[2]

Below is a sketch of the ball's potential energy against time for the first bounces.



k) ***sketch*** a graph of the ball's kinetic energy in the same time interval. You do not need to add a scale.



[3]

END OF EXAM