

2001 HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

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Centre Number

Section I - Part B (continued)

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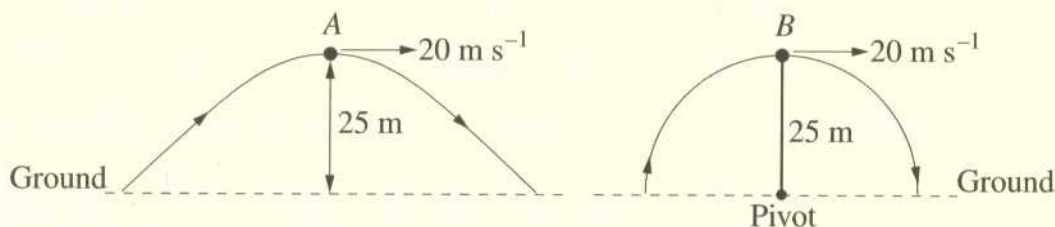
Student Number

Marks

Question 18 (6 marks)

A 30 kg object, A, was fired from a cannon in projectile motion. When the projectile was at its maximum height of 25 m, its speed was  $20 \text{ m s}^{-1}$ .

An identical object, B, was attached to a mechanical arm and moved at a constant speed of  $20 \text{ m s}^{-1}$  in a vertical half-circle. The length of the arm was 25 m.



Ignore air resistance.

- (a) Calculate the force acting on object A at its maximum height. 1

At A,  $a_y = 9.8$  and  $a_x = 0$   
 $\therefore a = 9.8$

Since  $F = ma$ , at A, force is zero  $\rightarrow$

$F = 30 \times 9.8$   
 $= 294 \text{ N}$   
 $= 290 \text{ N (2 sig figs)}$

- (b) Calculate the time it would take object A to reach the ground from its position of maximum height. 2

$v_y^2 = u_y^2 + 2a_y \Delta y$   
 $0 = 0 + 2 \times 9.8 \times 25$   
 $t^2 = 5.102 \dots$

$t = 2.26 \text{ s (2 sig figs)}$

- (c) Describe and compare the vertical forces acting on objects A and B at their maximum heights. 3

At A, at maximum height, vertical force is  $290 \text{ N (2 sig figs)}$

At B, vertical force at maximum height is equal to the gravitational force downwards minus the centripetal force acting upwards

ie.  $F_{\text{net}} = F_g - F_c$   
 $= 30 \times 9.8 - \frac{30 \times 20^2}{25}$  (ie  $\frac{mv^2}{r}$ )  
 $= -186 \text{ N} = -190 \text{ N (2 sig figs)}$

ie. Force at B at max height is equal to  $190 \text{ N}$  acting upwards.

$\therefore$  Magnitude of force at A is greater but forces at A and B are in opposite directions.



Marks

Question 19 (4 marks)

How does Einstein's Theory of Special Relativity explain the result of the Michelson-Morley experiment?

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Michelson-Morley experiment attempted to find the speed of the earth through the ~~ether~~ ether. A light beam was split by a half silvered mirror then reflected ~~and~~ back to the half silver mirror and directed towards a light observer. An interference pattern was observed. By rotating the half silvered mirror  $90^\circ$ , the velocity of the earth through the ether would either add, or subtract against the speed of the light and so a different interference pattern was expected. However, the interference pattern was the same, and so a null result occurred. Einstein explained this null result with his theory of special relativity, explaining that the speed of light was constant for observers in all frames of reference, and ~~that~~ so there was no ether.

Question 20 (4 marks)

The electrical supply network uses a.c. and a variety of transformers between the generating stations and the final consumer.

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Explain why transformers are used at various points in the network.

Transformers are used to step up voltages up to 500 kV to decrease current in transmission wires and so decrease energy losses due to heat. Power loss is given by  $P = I^2 R$ , so the lower the current the lower the power loss. ~~when~~ since  $P = IV$ , an increase in  $V$  decreases  $I$  so power loss is minimised by a step stepping the voltage up. when current ~~reaches~~ reaches substations for domestic use the voltage is gradually stepped down by transformers and then enters our homes at 240 volts.