

2001 HIGHER SCHOOL CERTIFICATE EXAMINATION
Physics

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Centre Number

Section I – Part B (continued)

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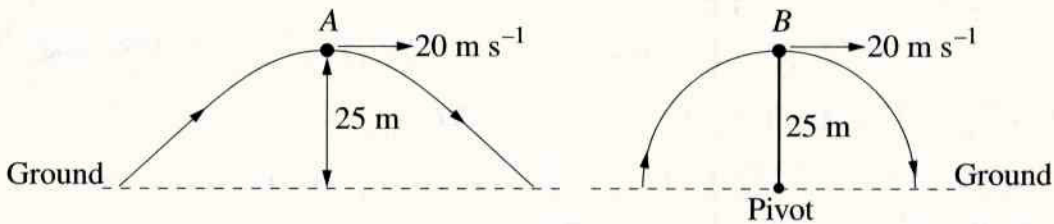
Student Number

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 m s^{-1} .

An identical object, B, was attached to a mechanical arm and moved at a constant speed of 20 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

only force is vertical (due to gravity) $F = mg$
~~ie $F_{net} = 294 \text{ N}$ down~~ $= 30 \times 9.8 \text{ m/s}^2$
 $= 294 \text{ N down (ie towards centre of earth)}$

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

Vertically: $u = 0$ $s = ut + \frac{1}{2}at^2$
 $a = 9.8 \text{ m/s}^2$ $25 = 4.9t^2$
 $s = 25 \text{ m}$ $\therefore t = 2.26 \text{ sec}$

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

A: vertical force due to gravity (weight): $F = mg = 294 \text{ N}$ down.

B: vertical force due to centripetal force (for circular motion) $F = \frac{mv^2}{r}$ and weight $F = mg$.

Note that weight $F = mg$ is part of the $F = \frac{mv^2}{r}$ as it helps the centripetal force.

ie $F_{net} = \frac{mv^2}{r} = \frac{30 \times 20^2}{25} = 480 \text{ N}$

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 conducted an experiment using an interferometer to measure the Earth's relative velocity to the ether. The interferometer split a light beam into two different paths and the difference in time arrival was determined by changes in interference patterns. The paths were equal and perpendicular to each other. Michelson-Morley found no changes in interference patterns no matter what angle the experiment was done. They concluded there was no ether. Einstein explained the result with his postulate that the speed of light is constant for all observers. Hence the light beams arrived at the same time no matter what angle they took. There would be no change in interference pattern since they would be in phase.

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 at various points in the network because they are used to distribute electricity to our homes. The transformer's use is to step up or step down voltage for transportation before being stepped down for domestic use. In the main power station which transports electricity from the plant voltage is stepped up so that the power loss of the electricity is minimized. This is governed by $P = I^2 R$ hence high voltage is used to minimize the current. However such high voltage is very dangerous to the consumer and hence it must be stepped down for home use. The power reaches the substation which steps down the voltage. AC is used for 2 primary reasons. firstly it is easily stepped up/down (transformed) by transformers. Secondly because all the phases may be synchronized and hence by completing the circuit in 3 phase power 2 of the phases may be destructively interfered with and hence only a single phase is used to complete the circuit. Hence it is very economical.