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RECOGNISING ACHIEVEMENT

Thursday 17 May 2012 – Morning

AS GCE PHYSICS A

G481 Mechanics

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator
- Ruler (cm/mm)
- Protractor

Duration: 1 hour

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Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 **(a)** State **one** difference between a scalar quantity and a vector quantity.

.....

..... **[1]**

(b) Fig. 1.1 shows two sets of quantities listed as 'scalars' and 'vectors' by a student.

scalars	vectors
acceleration	displacement
pressure	energy
stress	power
time	velocity
volume	weight

Fig. 1.1

(i) State the one quantity that has been incorrectly listed as a scalar.

..... **[1]**

(ii) State two quantities that have been incorrectly listed as vectors.

1. .....

2. ..... **[1]**

(iii) State two quantities listed as scalars that have the same unit. Name this unit.

1. .....

2. .....

unit: ..... **[2]**

(c) Circle the correct value for the prefix tera (T) in the list below.

10^6 10^9 10^{12} 10^{15} **[1]**

(d) Rearrange the following prefixes in the order of smallest to largest.

μ c p k

..... **[1]**

[Total: 7]

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2 Fig. 2.1 shows the path of a metal ball fired at a velocity of $24\,m\,s^{-1}$ at an angle of 30° to the horizontal.

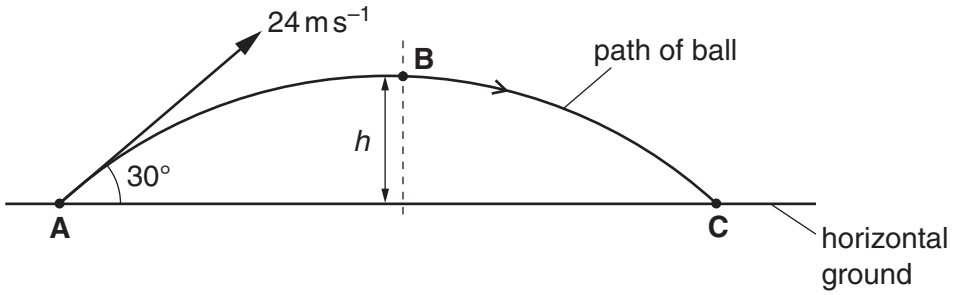


Fig. 2.1

Air resistance has negligible effect on the motion of the metal ball. The ball is fired from point **A** and it reaches its maximum height at point **B**. The mass of the ball is 450 g.

(a) State the direction of the acceleration of the ball during its flight.

..... **[1]**

(b) Calculate the horizontal and vertical components of the velocity of the ball at **A**.

horizontal velocity = ... $m\,s^{-1}$

vertical velocity = ... $m\,s^{-1}$ **[2]**

(c) Explain why the gravitational potential energy gained by the ball as it moves from **A** to **B** is not equal to its initial kinetic energy at **A**.

.....

.....

..... **[1]**

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(d) Calculate the maximum vertical height h of the ball.

h = ... m **[3]**

[Total: 7]

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3 **(a)** Define *velocity*.

.....

..... **[1]**

(b) Define *work done* by a force.

.....

..... **[2]**

(c) Fig. 3.1 shows a rider on a sledge sliding down an icy slope.

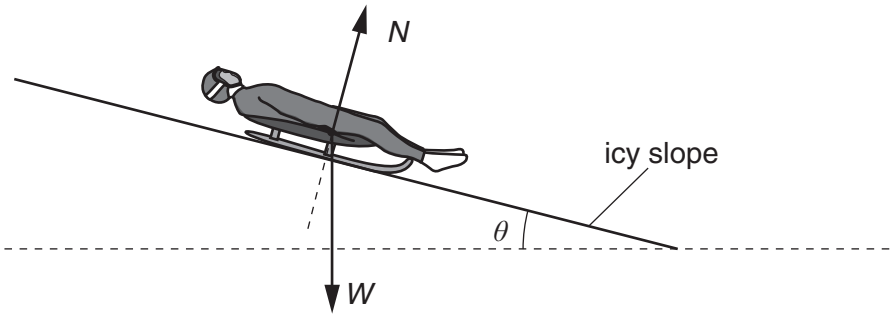


Fig. 3.1

The frictional forces acting on the sledge and the rider are negligible. The normal contact force *N* and the total weight *W* of the sledge and rider are shown.

(i) Explain why the force *N* does no work on the sledge as it slides down the slope.

.....

..... **[1]**

(ii) State and explain the force that causes the sledge and rider to accelerate down the slope.

.....

..... **[1]**

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(d) Fig. 3.2 shows the velocity against time graph for the sledge and rider in **(c)** sliding down the icy slope.

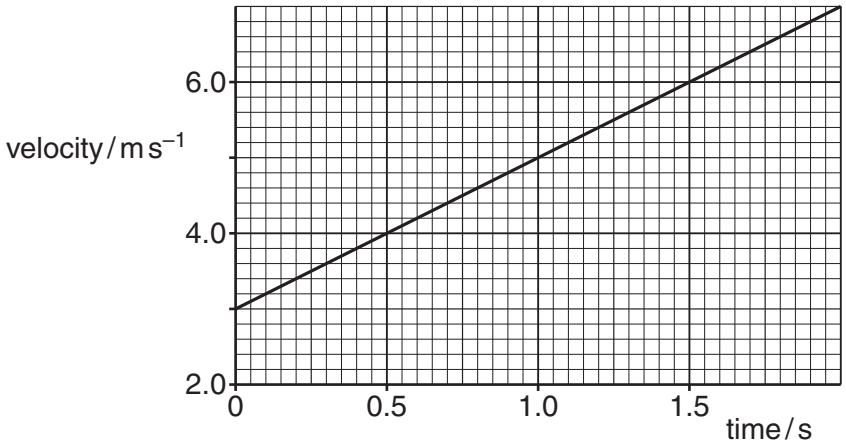


Fig. 3.2

(i) Use Fig. 3.2 to determine

1 the acceleration of the sledge and rider down the slope

acceleration = ... m s^{-2} **[2]**

2 the angle made by the slope to the horizontal.

angle = ...° **[2]**

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(ii) The sledge crashes into a foam barrier at the bottom of the slope.

The velocity of the sledge just before the impact is $15\,m\,s^{-1}$. The sledge and rider take 3.5 s to stop. The average decelerating force on the sledge and rider is 510 N.

Calculate the total mass of the sledge and rider.

mass = ... kg **[3]**

[Total: 12]

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4 **(a)** Define the following terms:

(i) *couple*

.....

..... **[1]**

(ii) *torque of a couple*.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(b) Fig. 4.1 shows a satellite in space moving from left to right.

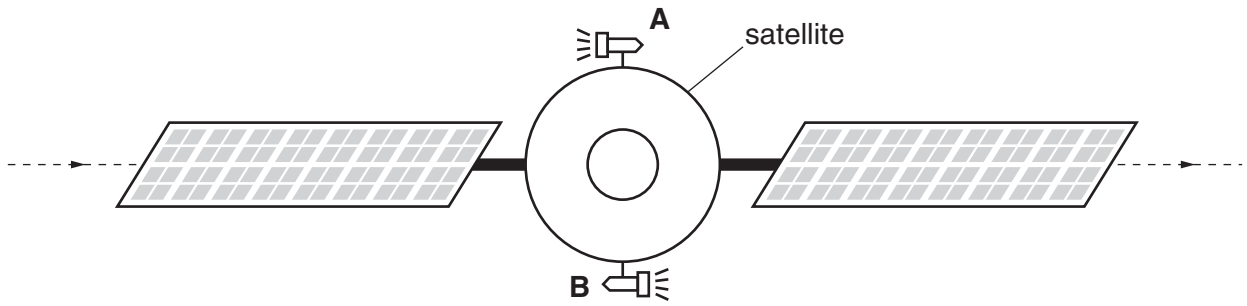


Fig. 4.1

The satellite has two small rockets **A** and **B** mounted at opposite ends of a diameter. When fired, each rocket motor provides the **same** constant force, but in **opposite** directions.

Describe the change in the motion of the satellite when

(i) both rocket motors are fired

.....

.....

..... **[2]**

(ii) only rocket motor **A** is fired.

.....

.....

..... **[2]**

[Total: 6]

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5 Fig. 5.1 shows the vertical forces acting on a helium-filled weather balloon just before lift off.

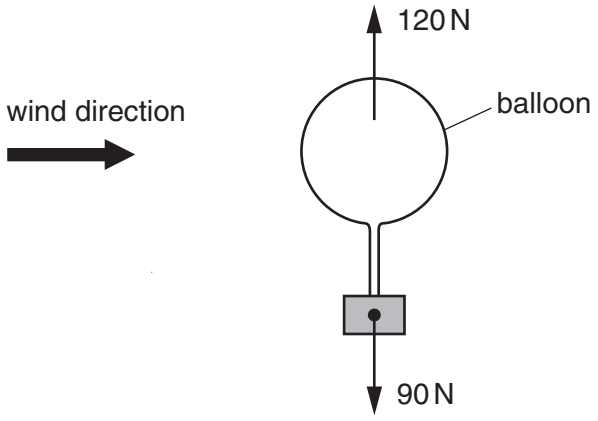


Fig. 5.1

The balloon experiences an upward vertical force (upthrust) equal to 120 N. The weight of the balloon and its contents is 90 N. The magnitude of the horizontal force provided by the wind is 18 N.

(a) Determine the magnitude of the resultant force acting on the balloon and the angle this resultant force makes with the horizontal.

net force = ... N

angle = ... °

[4]

(b) As the balloon rises through the air, it experiences a drag force. State two factors that affect the magnitude of the drag force on this balloon.

1. .....

2. ..... **[2]**

[Total: 6]

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6 **(a)** Fig. 6.1 shows the stress against strain graphs of two materials **X** and **Y**.

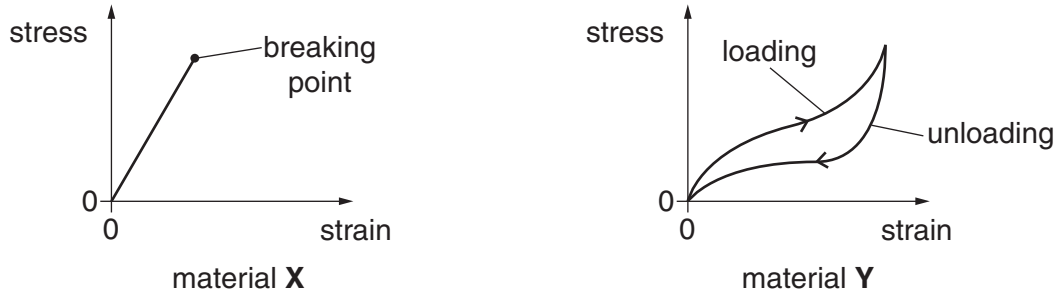


Fig. 6.1

Describe the properties of materials **X** and **Y**.

In your answer, you should use appropriate technical terms, spelled correctly.

material **X** .....

.....

.....

.....

.....

material **Y** .....

.....

.....

.....

..... **[5]**

(b) You are given a spring, a metre rule and a 100 g mass. Describe how you would determine the force constant *k* of the spring.

.....

.....

.....

.....

..... **[3]**

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(c) A glider of mass 0.180 kg is placed on a horizontal frictionless air track. One end of the glider is attached to a compressible spring of force constant 50 N m^{-1}. The glider is pushed against a fixed support so that the spring compresses by 0.070 m, see Fig. 6.2. The glider is then released.

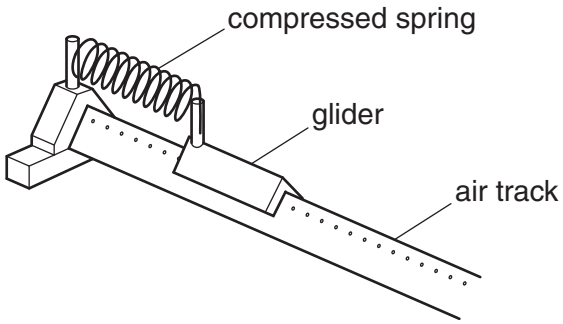


Fig. 6.2

(i) Calculate the horizontal acceleration of the glider **immediately** after release.

acceleration = ... m s^{-2} **[3]**

(ii) After release, the spring exerts a force on the glider for a time of 0.094 s. Calculate the average rate of work done by the spring on the glider.

average rate of work done = ... J s^{-1} **[2]**

[Total: 13]

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7 Fossil fuels will eventually run out. This has led to scientists looking for alternative sources of energy. Tidal stream systems use the kinetic energy of seawater to generate electrical energy during the incoming and outgoing tides. Fig. 7.1 shows a twin-turbine system in which flowing seawater turns the turbine blades.

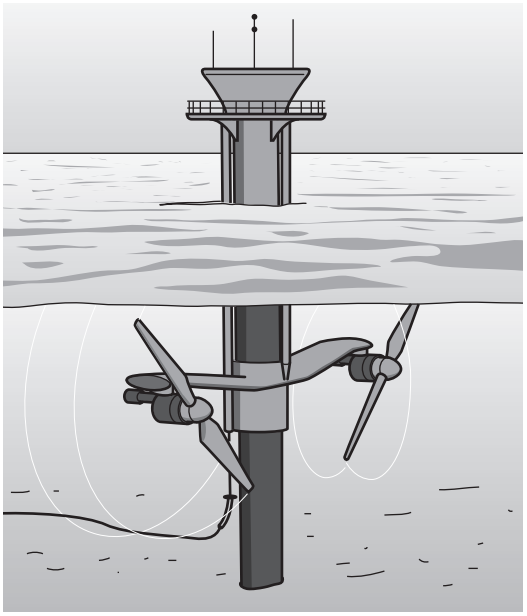


Fig. 7.1

When operating, 9.7×10^5 kg of seawater travelling at a speed of $3.0\,m\,s^{-1}$ passes through each turbine every second. Each turbine generates 1.2×10^6 W of electrical power.

(a) Define *power*.

.....

..... **[1]**

(b) The input power to each turbine is the kinetic energy of the seawater that flows through each turbine in one second.

Show that the input power to each turbine is 4.4×10^6 W.

[2]

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(c) Calculate the percentage efficiency of each turbine.

efficiency = ... % **[1]**

(d) In one second, a cylinder of seawater of mass 9.7×10^5 kg passes through each turbine at a speed of 3.0 m s^{-1}. Calculate the radius of each turbine. The density of seawater is 1030 kg m^{-3}.

radius = ... m **[3]**

(e) Tidal stream systems require less space than conventional wind turbines that are found in windy regions of this country.

(i) Explain why a tidal stream turbine system of identical size to a wind turbine system will produce greater power for the same water or wind speed.

.....

.....

..... **[1]**

(ii) Suggest one further advantage of tidal stream systems over conventional wind farms.

.....

..... **[1]**

[Total: 9]

END OF QUESTION PAPER

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ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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