Barbados S.D.A. Secondary School
Qualifying Examination 2005
Physics

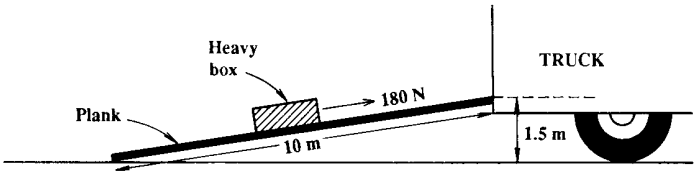
Name…… Time: 2½ hrs

Answer **ALL** questions in Section 1 of this paper.
In Section 2 answer **Question 3 and ANY TWO OTHER Questions** on foolscap paper.

Section 1

ALL WORKING MUST BE SHOWN on this paper, since marks will be awarded for correct steps in calculations.

Question 1



A plank of wood is used to help lift a heavy box, (weight 1000 N), into the back of a truck, as shown in Figure 3 above. The plank is 10 m long and the object rises to a vertical height of 1.5 m. A force of 180 N is used to pull the object along the plank.

(a) Define the unit of energy, the joule.

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(2 marks)

(b) Determine the change in gravitational potential energy of the box as it is lifted into the truck.

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(3 marks)

(c) How much work is done by the 180 N force?

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(3 marks)

(d) State the principle of conservation of energy and use it to explain why your answers to (b) and (c) above are not the same.

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(4 marks)

(e) Consider the plank of wood as a simple machine and calculate its efficiency.

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(3 marks)

Total 15 marks

Question 2

(a) Distinguish between vector and scalar quantities.

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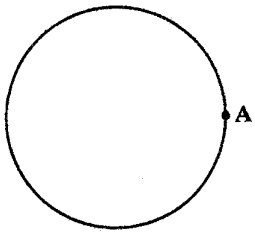
(2 marks)



(b) A small car travels at a constant speed around the circular track shown in the figure above, starting and finishing at Point A. The track has a radius of 70 metres and it takes 20 seconds to complete the journey. (Take π as 22/7 and the circumference = $2\pi r$, where r is the radius.)

(i) Find the distance travelled in 20 s.

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(1 mark)

(ii) Find the average speed of the car.

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(2 marks)

(iii) What is the average velocity for the complete journey?

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(1 mark)

(c) A car is travelling along a level road at 50 km h^{-1}. The car speeds up to 80 km h^{-1}. The driver finds that she has to keep her foot pressed harder on the gas pedal if she wishes to stay at this speed.

(i) How would Aristotle's Law of motion explain this observation?

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(2 marks)

(ii) Complete the following statement of Newton's first law of motion:
If the resultant force on a body is zero it will remain at rest or
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(1 mark)

(iii) Explain why the driver of the car must push harder on the gas pedal to keep the car moving at 80 km h^{-1}.
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(2 marks)

Total 11 marks

Section 2

Answer **Question 3 and ANY OTHER TWO Questions** on foolscap paper.

Question 3

You MUST answer this question. No more than ½ hour should be spent on this question.

A student investigates the properties of a spring and obtains the following results of the variation of the length of a spring with load.

Load/N	4.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0
Length/mm	18.4	20.5	22.4	24.3	26.4	*28.5*	31.3	36.4

(a) Use these values to plot a graph of length against load on the grid opposite. (10 marks)

(b) Find the slope, S, of the graph. (4 marks)

(c) Given that the spring constant = $\frac{1}{S}$ find the spring constant. (2 marks)

(d) Use your graph to determine the spring's length when the load is zero (2 marks)

(e) What is the value of the spring's EXTENSION when the load attached is 14 N? (2 marks)

(f) What mass must be placed on the spring to produce and extension of 9 mm? (5 marks)

Total 25 marks

Question 4

(a) State the unit of energy and the law of conservation of energy. (3 marks)

(b) For the following processes, state the main energy conversions involved:
- (i) A burning candle
- (ii) A car travelling at constant speed
- (iii) The generation of hydro-electricity (5 marks)

(c) A ball of mass 0.5 kg is dropped from a height of 10 m onto a hard surface. The ball rebounds to one-half its original height. Neglecting air resistance, determine the
- (i) speed of the ball at the instant it hits the surface
- (ii) amount of energy lost on impact with the surface
- (iii) speed of the ball as it rebounds from the surface
- (iv) speed and acceleration of the ball at the highest point it reaches after rebounding. (The acceleration due to gravity, g = 10 ms^{-2})

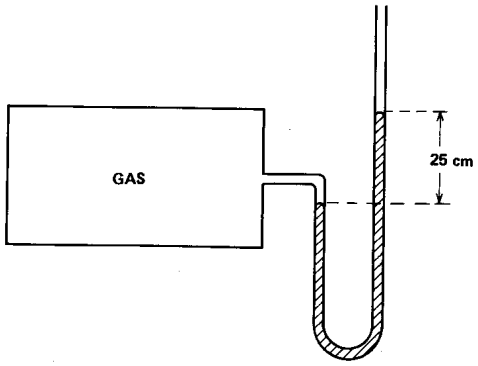
(12 marks)

Total 20 marks

Question 5

(a) With the aid of a labelled diagram, describe the structure of a simple mercury barometer
How do barometer readings provide an indication of the approach of a hurricane?
(6 marks)

(b) An open ended mercury manometer is connected to a cylinder containing gas at room temperature of 27°C, as shown in the figure below. The manometer reading is 25 cm and the mercury barometer reading at the time is 75 cm.



Calculate the pressure, in Pa, of the gas in the cylinder. (4 marks)

(c) (i) A boy is riding a bicycle with tyres pumped to a pressure of 5.0×10^5 Pa. Given that the combined mass of the boy and the bicycle is 75 kg, calculate the area of the tyres that Is in contact with the road. (3 marks)

(ii) Why is the pressure in the tyre of a racing bicycle usually higher than that in a motor car tyre? (2marks)
(Density of mercury = 1.36×10^4 kg m^{-3}; g = 10 N kg^{-1})

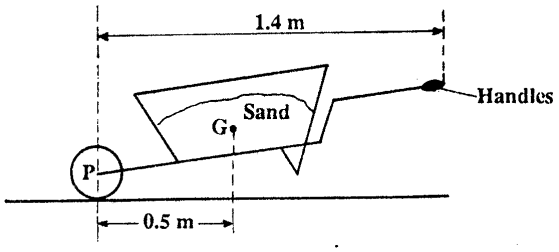
(c) Use Archimedes' principle to explain how a submarine can both float and sink.
(5 marks)
Total 20 marks

Question 6

(a) (i) Explain, with the aid of a diagram, what is meant by the moment of a force.

(ii) What do you understand by the term 'centre of gravity'?
Explain why, in the absence of other forces, an object may be balanced at its centre of gravity. (4 marks)

(b) The diagram below represents a wheelbarrow containing a load of sand.



The container and load are pivoted at P and have a mass of 40.0 kg. Their centre of gravity, G, is 0.5 m from P and the handles of the wheelbarrow are 1.4 m from P. The handles are being held so that the wheelbarrow is in equilibrium as shown in the diagram above.

(i) Name the principle that must be satisfied for the wheelbarrow to be balanced. Explain how this principle applies in this case. (2 marks)

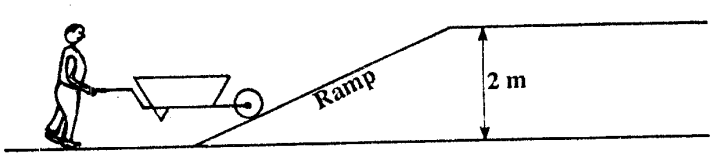
(ii) Calculate the upward force which is being provided at the handles. (3 marks)

(iii) Calculate the upward force at the axle, P, of the wheelbarrow. (3 marks)

(iv) Explain the advantage of redesigning the wheelbarrow so that the centre of gravity is much closer to the point, P. (2 marks)

(v) More sand is added to the wheelbarrow. Explain why this makes the wheelbarrow more likely to tip over to one side. (2 marks)

(c)



The wheelbarrow (mass 40 kg) is now wheeled up a ramp and gains 2 m in height, as shown in the diagram above. The work done is 1400 J.

Calculate the change in the gravitational potential energy of the wheelbarrow. Treating the ramp as a machine, calculate its efficiency.

($g = 10\ N\ kg^{-1}$)

(4 marks)

Total 20 marks

Section 3

On your answer sheet, circle the letter corresponding with the correct answer.

1. Which of the following relations expresses Aristotle's 'law of motion'?
(F = force, v = velocity, a = acceleration)

(A) $F \propto v$ (B) $F \propto v^2$ (C) $F \propto a$ (D) $F \propto \frac{1}{a}$

2. Which quantity is NOT a vector?
(A) momentum (B) velocity (C) pressure (D) displacement

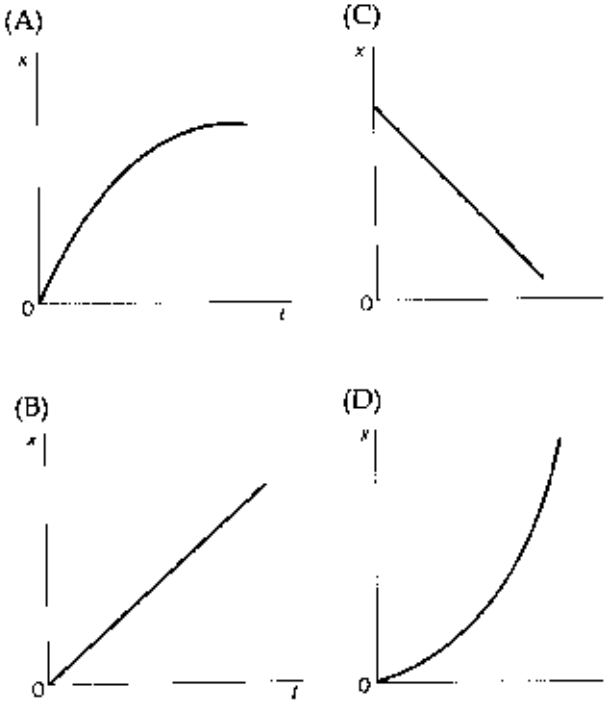
3. The SI unit of power is equivalent to
(A) l Nm (B) l Nms^{-1} (C) 1 Ns (D) l ms^{-1}

4. The number $1.053 \times l0^4$ could also be written as
(A) 1 053 (B) 10530 (C) 15300 (D) 105300

5. 3.6 MW is the same as
(A) 3600 W (B) 36000 W (C) 360000 W (D) 3600000W

6. What is the volume of 6.0 kg of paint of density 1.2 gcm^{-3}?
(A) 500 cm^3 (B) 1200 cm^3 (C) 5000 cm^3 (D) 7200cm^3

7. A car travelling at 30 km h^{-1} comes to rest with uniform retardation. Which graph shows how its displacement, *x*, changes with time, *t*, as it decelerates?

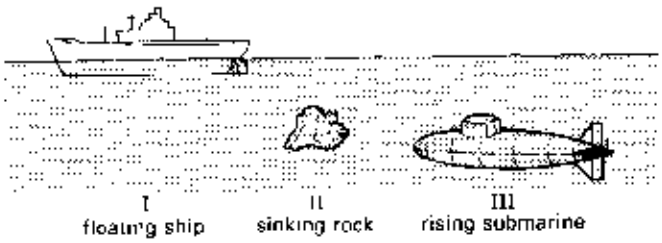


8. Which of the following quantities are proportional to the pressure at the bottom of a column of liquid?

I the height of the column
II the density of the liquid
III the area of the column

(A) I only (B) I and II only (C) II and III only (D) I, II and III

9. Which of the objects shown has/have an *upthrust* acting on it/them?



(A) I only (B) I and II only (C) II and III only (D) I, II and III

10. A small truck, mass *m*, travelling at speed *v* collides with an identical truck. After the collision the trucks stick to each other and move off together. The total kinetic energy of the two trucks after the collision is

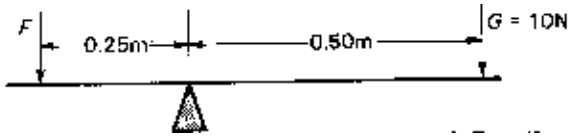
(A) mv^2 (B) $\frac{mv^2}{2}$ (C) $\frac{mv^2}{4}$ (D) $\frac{mv^3}{8}$

11. Which row gives the correct multiplying factors corresponding to the SI prefixes mega and micro?

	Mega	*Micro*
(A)	10^6	10^{-6}
(B)	10^{-6}	10^6
(C)	10^6	10^{-3}
(D)	10^{-3}	10^{-6}

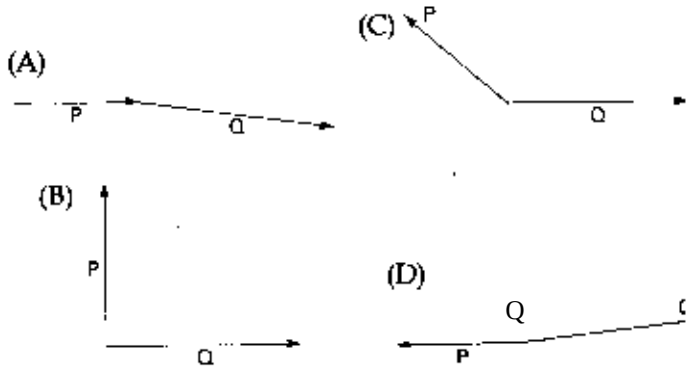
12. Which of the following is NOT a fundamental quantity in SI?
(A) charge (B) length (C) temperature (D) time

13.



The diagram shows two forces *F* and G, acting on a rod of negligible weight. The rod is in equilibrium. If G is 10 N the magnitude of the force exerted by the pivot on the rod is
(A) 10N (B) 20N (C) 30N (D) 40N

14. In which diagram is the magnitude of the resultant of the two forces P and Q the largest?



15. A rock of mass 2 kg falls 125m from a cliff into the sea below (g = 10N kg-1). Its speed just before it hits the water is
(A) l0 ms^{-1} (B) 25ms^{-1} (C) 50ms^{-1} (D) 100ms^{-1}

16. A rock of mass 2 kg falls 125m from a cliff into the sea below (g = 10N kg-1). Its speed just before it hits the water is
(A) l0 ms^{-1} (B) 25ms^{-1} (C) 50ms^{-1} (D) 100ms^{-1}

17. A steel ball bearing and a table-tennis ball with exactly the same diameter are dropped simultaneously. The steel ball is observed to hit the ground first. Which of the following statements about the balls is/are true?
I The upthrust of the air on the table-tennis ball is greater than that on the steel ball
II Their initial accelerations are equal
III At the same speed they experienced the same force due to air resistance
(A) I only (B) I and II only (C) II and III only (D) I, II and III

18. Which of the following is NOT a renewable energy source?
(A) coal (B) waves (C) wind (D) wood

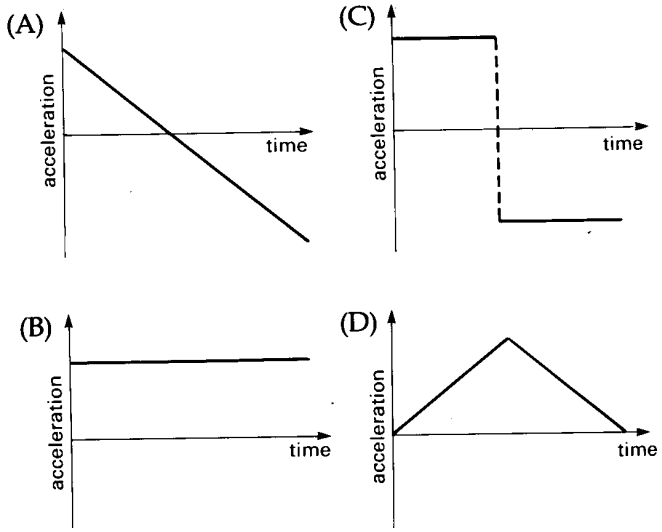
19. Power is equal to
(A) energy × time
(B) force × velocity
(C) mass × acceleration
(D) force × area

20. Two vectors of magnitude 6 units and 13 units CANNOT have a resultant of
(A) 7 units (B) 10 units (C) 13 units (D) 20 units

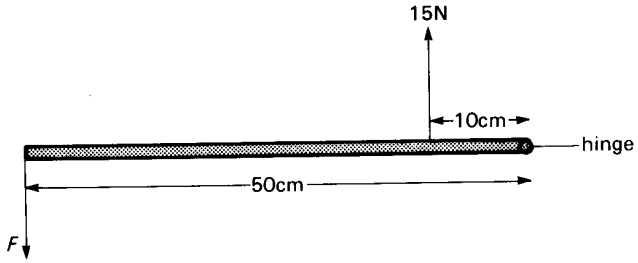
21. An object travels at constant speed in a circle. Which of the following statements about the object is/are true?
I It has no acceleration
II Its kinetic energy is constant
III It experiences a force towards the centre of the circle

(A) II only (B) I and II only (C) II and ill only (D) I, II and ill

22. A cricket ball is thrown vertically upwards and then caught again. If air resistance is ignored, which graph shows how the acceleration varies during the motion?



23. Which of the following is a scalar quantity?
(A) Force (B) Energy (C) Momentum (D) Displacement



24. The diagram represents a uniform rod 50 em long hinged at one end. Its weight is 4 N. How large is the force labelled F, acting at the end of the rod, if the rod is in equilibrium?
(A) 1N (B) 3N (C) 5N (D) 11N

25. $1\ \mu A \times 1\ kV$ is equal to
(A) 1mW (B) 1 W (C) 1kW (D) 1MW