ST JOSEPH'S INSTITUTION
PRELIMINARY EXAMINATION 2021
(YEAR 4)

CANDIDATE NAME								
CLASS						INDEX NUMBER		

PHYSICS **6091/02**

Paper 2 **23 August 2021**

1 hour 45 minutes
(11:15 – 13:00)

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the cover page of this Question Paper and all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions on the Question paper.

Section B
Answer **all** questions. Question 12 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
Candidates are advised to show formulae and all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

Section A								
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9

For Examiner's Use	
Section A	/ 50
Section B	/ 30
Total	/ 80

Section A (50 marks)

Answer all questions in this section.

1 A ball is thrown vertically upwards.

(a) If the ball is thrown with a velocity of 9.2 m/s, calculate the velocity of the ball 0.42 s after it has been thrown. Take acceleration due to gravity to be 10 m/s^2.

velocity = …….. [2]

(b) Calculate the maximum height the ball will reach.

maximum height = …….. [2]

(c) In Fig. 1.1, sketch how the ball's displacement changes with time, from the moment it is thrown, until the time it returns to the thrower.

Take its initial displacement to be 0.0 m. [1]

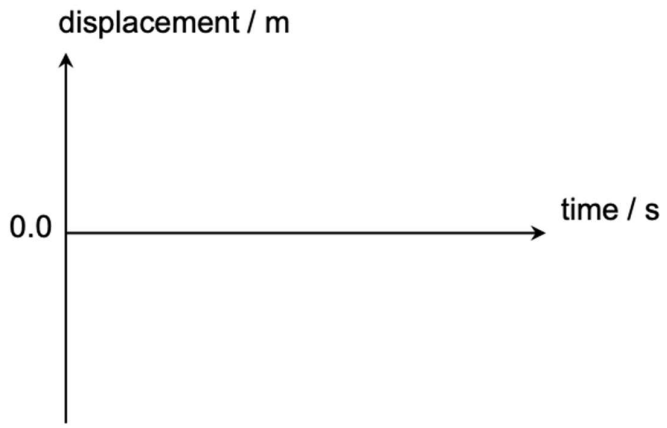

Fig. 1.1

(d) Explain why the ball reaches a lower maximum height when there is air resistance.

……

…… [1]

2 Fig. 2.1 shows a 5.0 kg object being pulled by a string at an angle of 60° to the horizontal. The string exerts a constant tension on the object, causing it to slide on the smooth horizontal surface at a constant acceleration of 0.50 m/s^2.
Air resistance can be ignored.

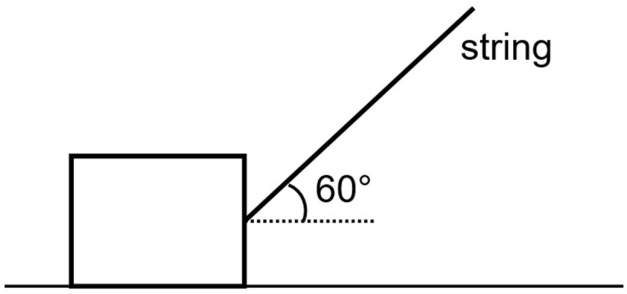

Fig. 2.1

(a) Calculate the resultant force acting on the object.

resultant force = ... [1]

(b) In the space below, draw a labelled diagram to show the resultant of all the forces acting on the object.

Determine the magnitude of the tension of the string.

tension = ... [3]

(c) A student suggests that since the object is moving horizontally, the vertical component of the tension of the string must be equal to the weight of the object.

Explain why in this situation, the weight of the object is larger than the vertical component of the tension.

……

……[1]

(d) After pulling the object for a certain distance, the string snaps. State and explain the subsequent motion of the object.

……

……[1]

3 Fig. 3.1 shows a hydraulic waste compacting machine designed to reduce the volume of plastic waste for ease of waste management. When the handle is pushed downwards, a force is exerted on the piston A that compresses the plastic waste above piston B. The enclosed space is filled with oil. The cross sectional area of piston A and piston B are 10 cm^2 and 0.25 m^2 respectively.

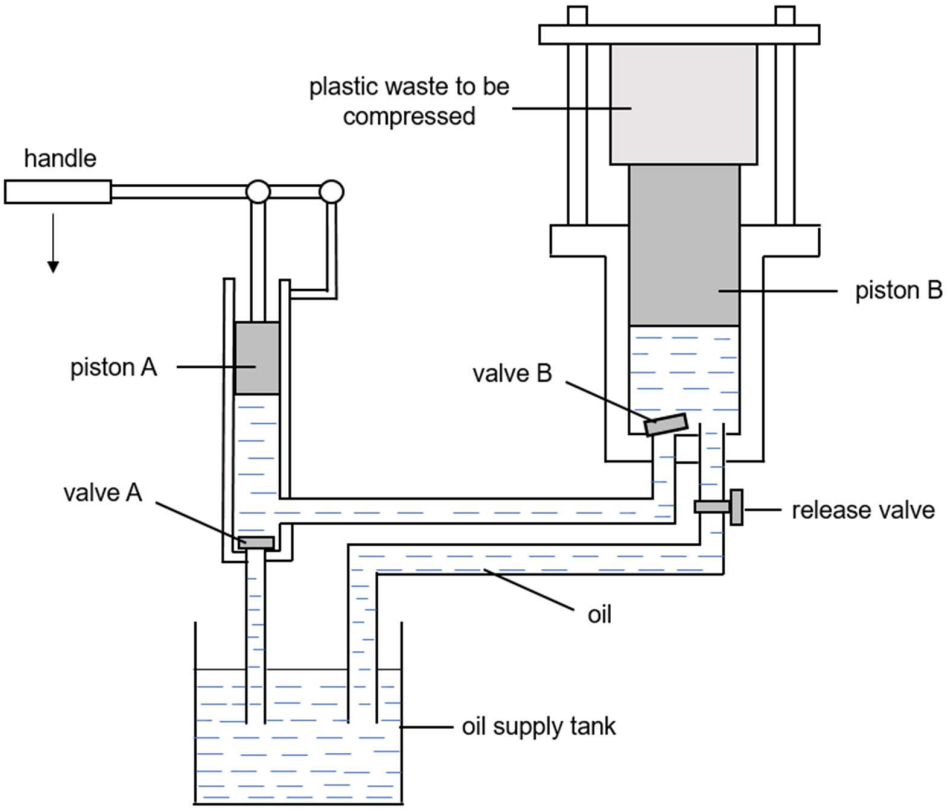

Fig. 3.1

(a) Explain why a liquid is preferred over a gas in such a machine.

……

…… [1]

(b) Using ideas about pressure, explain why piston B will exert a large force to compact the plastic waste.

……

……

……

…… [2]

(c) Calculate the force exerted on piston B if a force of 10 N is exerted on piston A.

force = …… [2]

(d) Explain why valve A opens upwards when the handle is lifted after the plastic waste is compacted.

……

……

……

……[1]

4 A 500 g metal container was half-filled with 500 g of water and was covered by a lid such that the container was air-tight. The initial temperature of the metal container was 30°C. The metal container was then heated with a heater.

The specific heat capacity of the water is 4200 J/kg°C.
The heat capacity of the metal container is 4.5 J/°C.

(a) The water started to boil after 2.0 min of heating. Calculate the power of the heater.

power = …….. [2]

(b) The container continued to be heated. After heating for another 1.5 min, the lid of the container flew off from the container.

Using ideas of molecules, explain why the lid flew off from the container.

……

……

……

……

……

..... [2]

5 Ultrasound is used in many industries to measure liquid depth in a closed container. A transmitter/receiver is attached at the bottom of the container. An example of such a container is shown in Fig. 5.1.

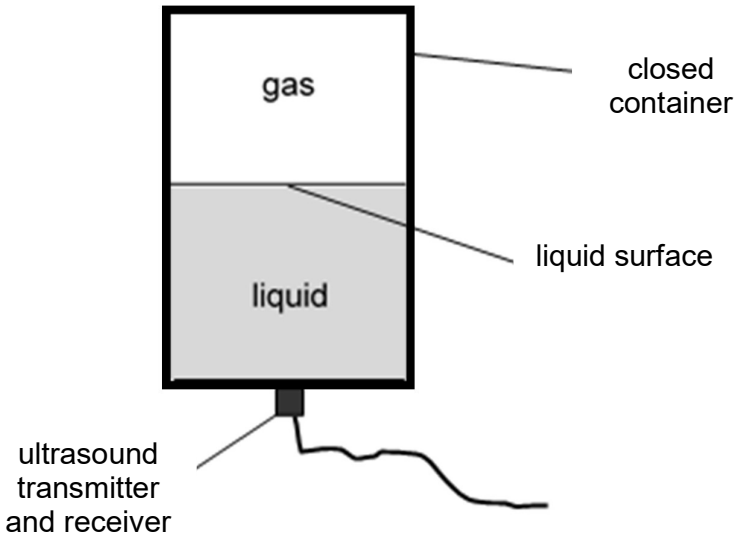

Fig. 5.1

A pulse of ultrasound is transmitted into the liquid. The pulse travels up through the liquid until it reaches the surface, where it is reflected and returned through the liquid to the receiver. By measuring the time taken for the echo to reach the receiver, the depth of the liquid in the container can be calculated.

(a) On Fig. 5.2, show with arrow(s), how a liquid particle moves with respect to the ultrasound wave.

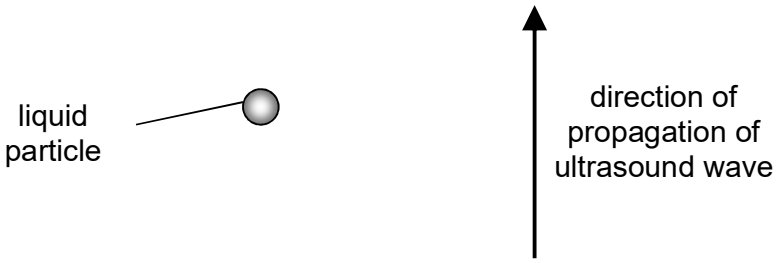

Fig. 5.2

[1]

(b) Describe how sound energy is transferred through the liquid without transferring matter.

……

……

……[2]

(c) The speed of ultrasound in the liquid is 1500 m/s while its speed in the gas is 330 m/s.

(i) Explain why the speed of ultrasound is greater in the liquid than in the gas.

……

……[1]

(ii) Calculate the depth of the liquid in the container if the ultrasound took 2.0 ms to return to the transmitter after it was emitted.

depth = …… [1]

(iii) The frequency of the ultrasound used is increased from 40 kHz to 50 kHz. State and explain whether this causes the time taken in **(ii)** to be shorter, longer or remains the same.

……

……[1]

6 Fig. 6.1 shows a device that emits a light which is used in a dental filling procedure. When in use, a narrow beam of light is emitted from the end as shown.

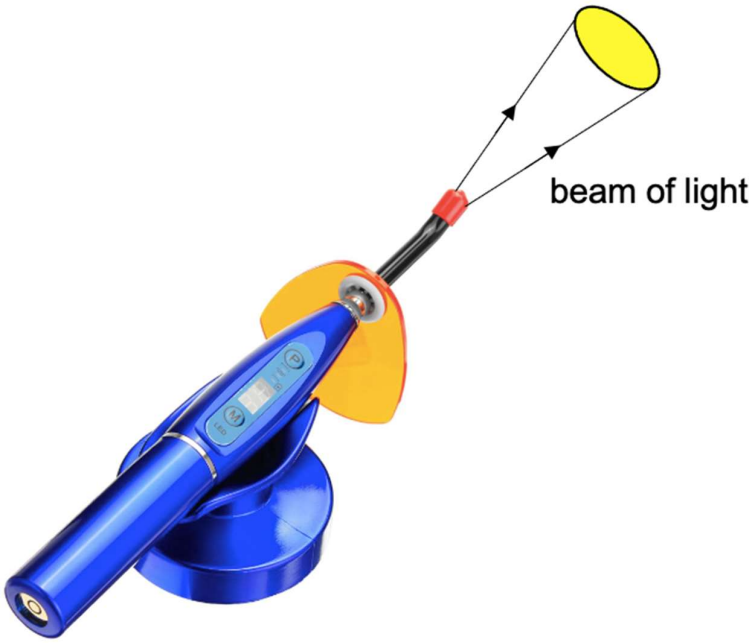

Fig. 6.1

https://www.joom.com/en/products/5af416b48b451301af7ba711

A liquid filling is first applied into the cavity of the tooth. Light is then directed on the filling and the energy of the light causes the filling to harden. The device is powered by a rechargeable battery.
The specifications of the device are as follows:

Specifications	
Charging voltage	12 V
Battery life for continuous use	120 minutes
Battery charging time from 0 V to maximum	90 minutes
Power of light incident per unit area	0.75 W/cm^2

Table 6.1

(a) In one procedure, the area of the filling was 0.12 cm^2. Calculate the amount of energy incident on the filling in one second.

energy = ... [1]

(b) The average charging current is 1.1 A.

(i) State what is meant by a current of 1.1 A.

……

…… [1]

(ii) When the battery is fully charged, calculate

1 the charge in the battery,

charge = …… [1]

2 the amount of energy stored.

energy = …… [1]

(iii) Determine the average rate at which energy in a fully charged battery is dissipated when used continuously.

rate of energy dissipation = …… [1]

(iv) Explain why the rate of energy dissipation calculated in **(b)(iii)** is higher than the power given in Table 6.1.

……

……

…… [1]

7 Two identical electric immersion heaters with a rating of “1100 W, 240 V” are connected to the mains circuit at 240 V as shown in Fig. 7.1.

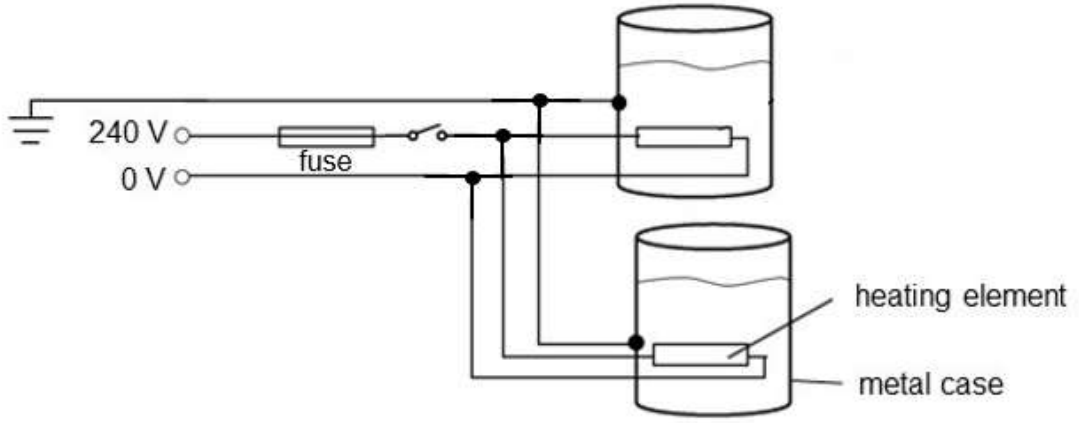

Fig. 7.1

(a) Fuses of 3 A, 5 A and 13 A are available. Determine the value of a suitable fuse rating used in Fig. 7.1.

fuse rating = ... [2]

(b) An electrician connected the two immersion heaters in series to test their heating capabilities. Explain, why the total power supplied by the mains to the heater is now a quarter of that supplied originally when the heaters are connected as in Fig. 7.1.

.....

.....

..... [2]

8 Fig. 8.1 shows a simple d.c. motor.

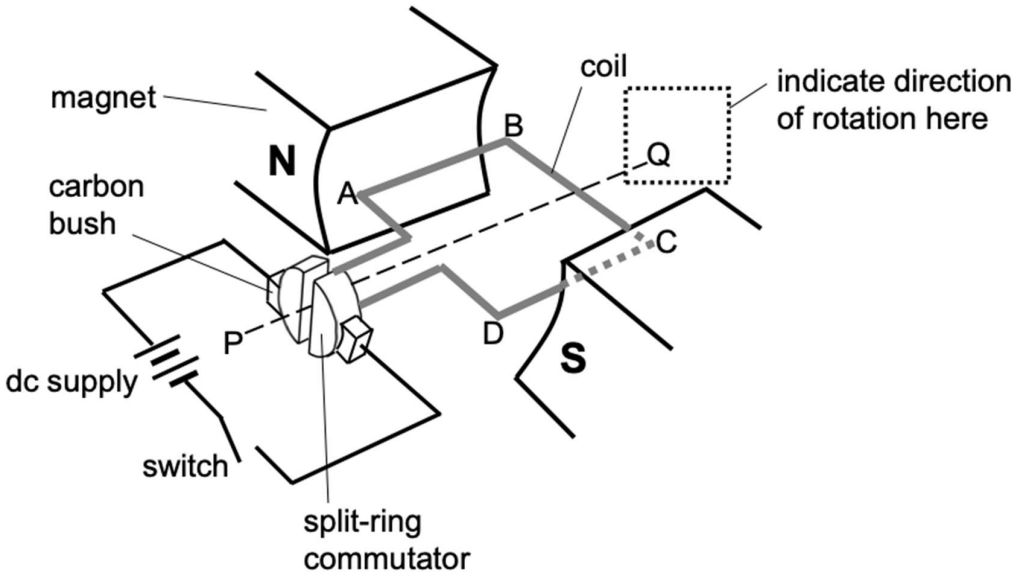

Fig. 8.1

The coil is in the horizontal position and the coil rotates about an axis PQ.

(a) The switch is closed and the coil starts to rotate. In the box provided on Fig. 8.1, draw the direction of rotation about the axis PQ. [1]

(b) Explain why a force acts on the coil segment AB.

……

……

……[2]

(c) Explain why the coil rotates continuously in the same direction.

……

……

……[2]

(d) The moment of the force acting on the coil varies over time. In Fig. 8.2 sketch the change of moment of the force over half a complete rotation. [1]

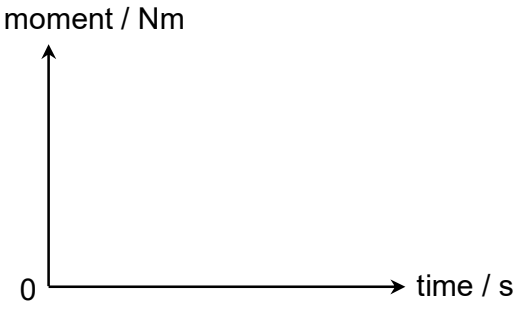

Fig. 8.2

9 **(a)** The belted kingfisher is a diving bird that hunts for small fishes in the river. Fig. 9.1 shows a kingfisher diving vertically into a river due to gravity.

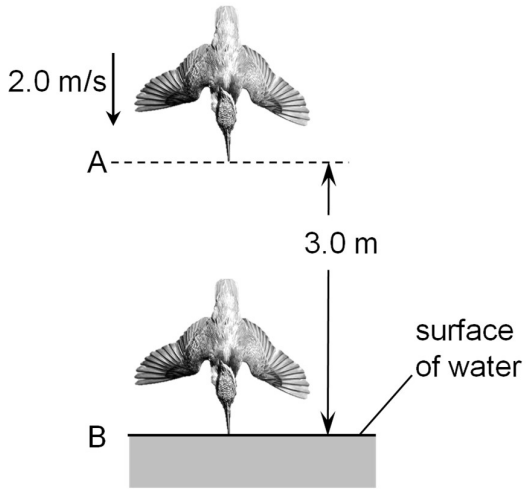

Fig. 9.1 (not drawn to scale)

(i) From point A located 3.0 m above the water surface, the kingfisher dives at an initial velocity of 2.0 m/s. It has a mass of 0.15 kg and reaches a velocity of 6.6 m/s just before it enters the surface of the water at point B.

Find the work done against air resistance. Take gravitational field strength to be 10 N/kg.

work done = …….. [2]

(ii) The kingfisher experiences air resistance as it dives through the air. Identify the action-reaction pair of forces in this scenario.

……..

……..... [1]

(iii) After travelling to a certain depth into the water, the kingfisher comes to a stop as it catches its food.

Describe how the principle of conservation of energy applies to the kingfisher from the moment it enters the water to the moment it comes to a stop.

……..

……..

……..

……..

……..

……..

……[2]

(b) Another type of kingfisher, the Pied kingfisher, is able to hover over the water before making a dive to catch its prey.

For a bird to hover in the air, it requires energy to do so. Explain how work is done even though the Pied kingfisher does not have any net movement when it is hovering.

……

……[1]

END OF SECTION A