Name: _____ Register Number: _____ Class: _____

For Marker's Use

南僑中學

NAN CHIAU HIGH SCHOOL
PRELIMINARY EXAMINATION THREE 2015
SECONDARY FOUR EXPRESS

PHYSICS **5059/02**

Paper 2 Theory **15 Sep 2015, Tuesday**

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

INSTRUCTIONS TO CANDIDATES

Write your name, class and register number in the spaces provided at the top of this page.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided 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.
You may lose marks if you do not show your working or if you do not use appropriate units.
The number of marks is given in brackets [ ] at the end of each question or part question.

The total marks for this paper is 80.
g = 10.0 N/kg on earth.

This paper consists of **20** printed pages including the cover page.

Section A
Answer **all** the questions in this section

1. (a) Define velocity. [1]

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(b) A solid rubber ball drops and hits the floor 0.60 s later. A velocity-time graph of the motion is shown in Fig. 1.1 below.

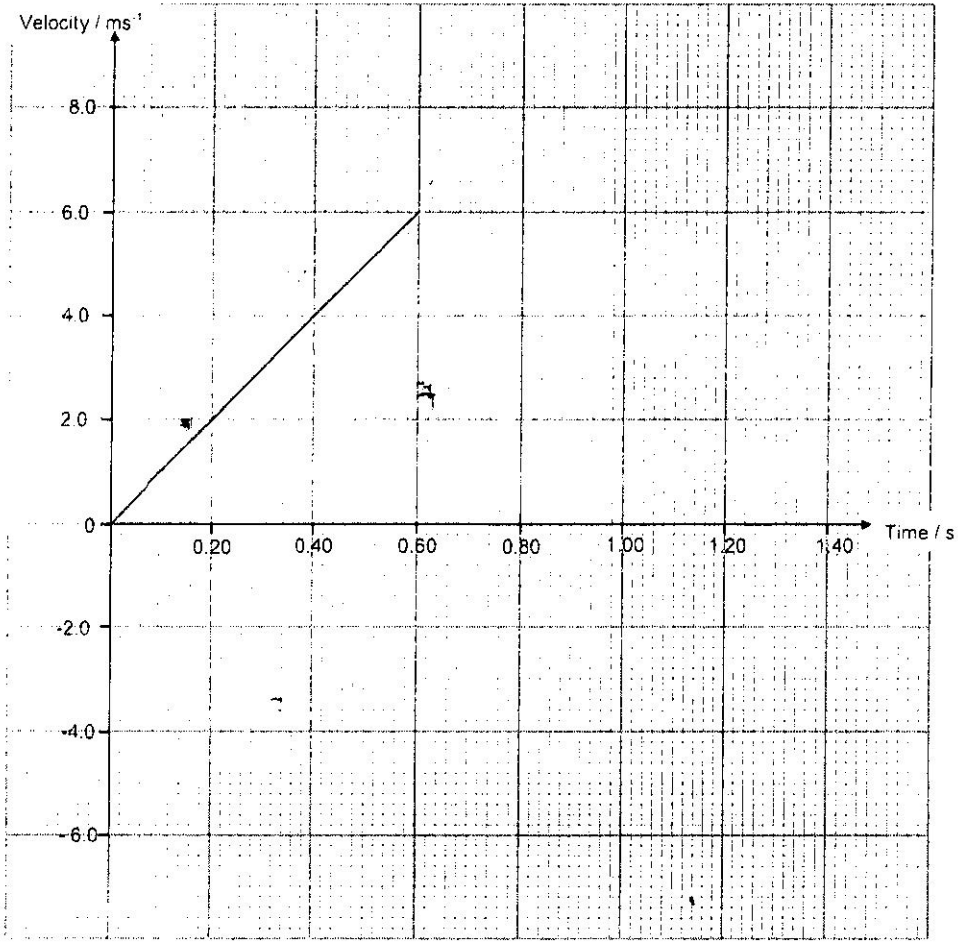

Fig. 1.1

1. (b) The ball makes contact with the floor for 20 ms, after which it **rebounds vertically** with an initial **speed** of 5.6 ms^{-1}.

(i) Calculate the acceleration of the ball while it makes contact with the floor and rebounds. [2]

(ii) Calculate the maximum height during the ball's bound [1]

(iii) Draw on Fig. 1.1 the velocity-time graph for the ball during its rebound to the maximum height. [2]

2. A box with a mass of 4.0 kg was pushed by a force of 18 N along a table-top as shown in Fig. 2.1. The displacement-time graph of the motion is given in Fig. 2.2.

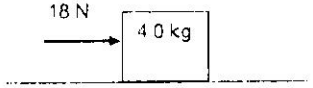

Fig. 2.1

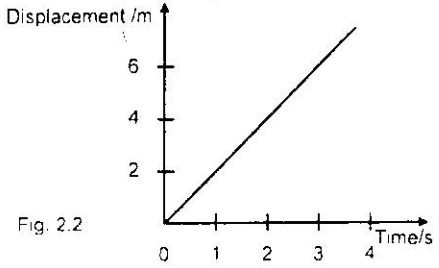

Fig. 2.2

(a) From Fig. 2.2, determine the frictional force acting on the block when the box is moving. Explain your answer. [2]

(b) While the box is still moving on the same surface, the push was increased to 20 N. Describe the subsequent motion of the box after the change in force occurs, giving numbers where necessary. [2]

3. A uniform trap door weighs 80 N. It is lifted up and held stationary by a force of 50 N as shown in Fig. 3. The centre of gravity of the trap door is located at 60.0 cm from the hinge as shown.

(a) State the meaning of centre of gravity. [1]

(b) By means of a scaled diagram, determine the reaction at the hinge of the trap door. [3]

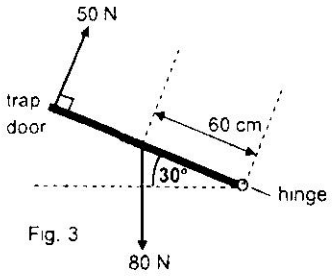

Fig. 3

4. A 1.00 m long barometer tube was filled with mercury to the brim of the tube. The open end was held carefully by the thumb and then inverted in a trough of mercury. The thumb was then removed. Fig. 4.1 shows the barometer at the instant when the thumb was just removed

(a) (i) Show that the level of mercury in the tube above the surface of mercury in the trough would become 0.743 m eventually.
The atmospheric pressure has been determined to be 101000 Pa and mercury has a density of 13.6 g/cm^3. [2]

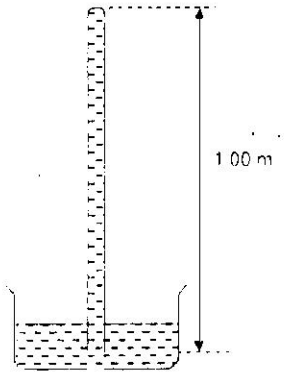

Fig. 4.1

(ii) Suggest a simple way to check that the barometer reads only the atmospheric pressure and not any additional pressure due to any gas trapped in the tube [1]

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(b) A mercury barometer is shown in Fig. 4.2. Draw the new level of the mercury level in the barometer and the reservoir when the barometer is brought to a mountain top, which has an altitude of 4000 m. Assume that the density of air is constant at 1.23 kg/m^3 and atmospheric pressure on the sea level is 103360 Pa. Show all calculations clearly [2]

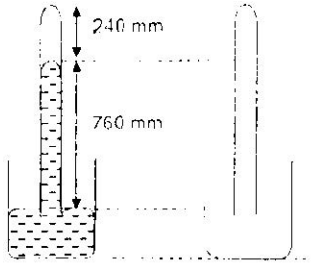

Fig. 4.2

5. Fig 5.1 below shows a hand-operated hydraulic jack.

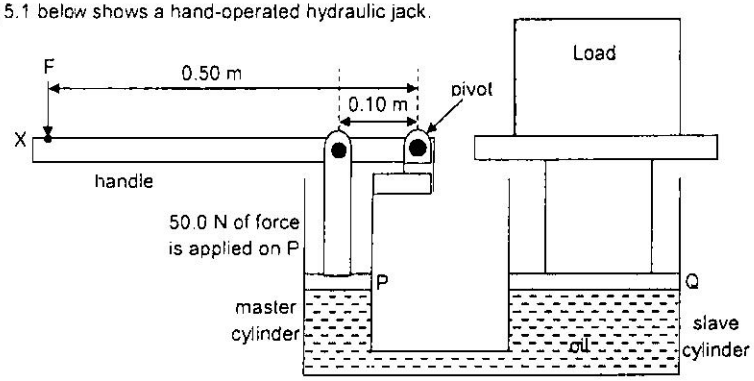

Fig. 5.1

Piston P and the handle are linked through the same pivot. When a force is applied downwards at point X, piston P in the master cylinder is pushed down with a force of 50.0 N, causing oil to flow into the slave cylinder.

(a) Calculate the moment of the force of 50.0 N applied on piston P. [1]

(b) The area of piston P is 20.0 cm^2 and the area of piston Q is 800 cm^2.
Calculate the load being pushed upwards by piston Q. [2]

(c) If piston P moved a distance of 10.0 cm downwards, determine the distance moved by piston Q upwards. [2]

6. (a) State a difference between boiling and evaporation. [1]

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(b) In an experiment to demonstrate how the boiling point of water depends on the surrounding pressure, a beaker containing hot water at 80 °C was placed inside a bell jar, which was all sealed up other than allowing for an exit to a vacuum pump.

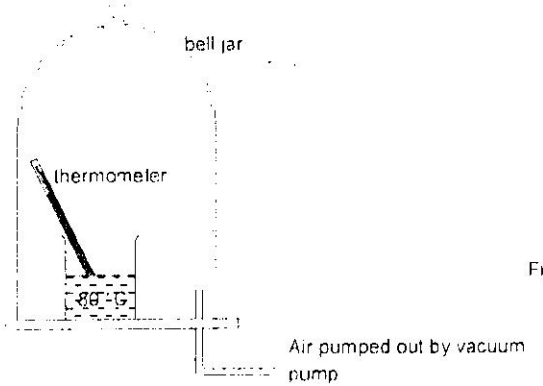

Fig. 6.1

Explain using kinetic model of matter.

(i) why some of the water boil when the air was being pumped out? [2]

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(i) why the temperature of the remaining water becomes lower? [2]

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7. At coastal areas, the sea breeze is formed at around 3.00 p.m.

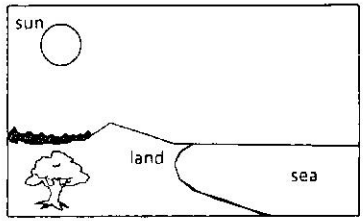

Fig. 7.1

(a) (i) In Fig. 7.1, draw the direction of the convection currents to form the sea breeze. [1]

(ii) Explain how the sea breeze could have been formed. [2]

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(b) The following data may be useful in this question.
Specific heat capacity of water = 4.20 kJ kg^{-1} K^{-1}.
Specific heat capacity of aluminium at 100°C = 0.910 kJ kg^{-1} K^{-1}.
Latent heat of vaporisation of water = 2260 kJ kg^{-1}.
Latent heat of fusion of water = 334 kJ kg^{-1}.

A 3.00 kg block of aluminium is heated to 600°C. It is placed in a container holding 2.00 kg of water at 25°C. The hot aluminium brings the water to its boiling point at 100°C quickly.

(i) Calculate the amount of energy given out by the aluminium block when its temperature is lowered to 100°C. [1]

(ii) Calculate the mass of water which will boil when the temperature of aluminium is at 100°C and 5000 J of energy has heated up the air surrounding the container. [3]

8. (a) A positively-charged sphere is placed near a neutral metal plate which was placed on an insulator shown in Fig. 8.1.
Draw the electric field between the sphere and the metal plate. [2]

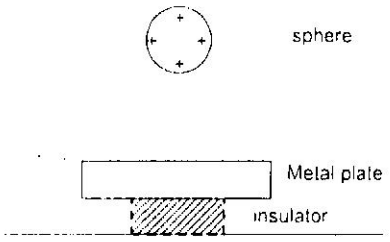

Fig. 8.1

(b) Fig. 8.2 shows part of an electrostatic spray gun applying paint onto a piece of metal part. The nozzle sprayed out fine paint droplets. The droplets are charged positively as they emerged.

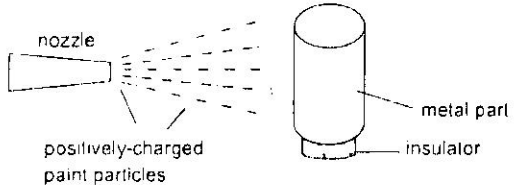

Fig. 8.2

(i) Explain why the positively-charged paint droplets are attracted to the neutral metal part. [2]

(ii) Explain how the positively-charged paint droplets are spread out evenly to form a coat of paint on the metal part. [2]

9. (a) A 200 m long spool of wire has a diameter of 0.30 mm. If the wire has a reistance of 48.8 Ω, calculate the resistivity of the wire. [2]

(b) A circuit is connected as shown in Fig. 9.1. The bulb is intended to be lit up when the surroundings has become darker.

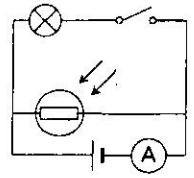

Fig. 9.1

(i) Explain why the circuit in Fig. 9.1 will not work as intended after the switch is closed. [2]

(ii) A second identical bulb is connected in parallel to the first bulb as shown in Fig. 9.2.

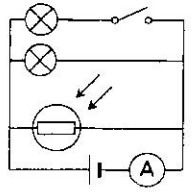

Fig. 9.2

Describe how the additional bulb affects the ammeter reading when the switch is closed. [1]

9. (c) John wants to construct a circuit that switches on a 18 V fan motor for his computer when the temperature is high.

(i) Complete the design of the circuit below to switch on the fan motor when the temperature rises. No calculation is required.

Choose from the following components:

- Light dependent resistor,
- light emitting diode (LED),
- rheostat,
- connecting wires,
- switch and
- negative temperature-coefficient thermistor. [2]

(ii) Explain how the circuit would be switched on. [1]

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Section B

Answer **all** the questions in this section.

Answer only one of the two alternative questions in **Question 12**.

10. (a) (i) What do you understand by the refractive index of water is 1.33? [1]

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(b) A ray of light is incident towards the centre of a semi-circular glass block as shown in Fig. 10.1. X is the curved surface area of the semi-circular glass block.

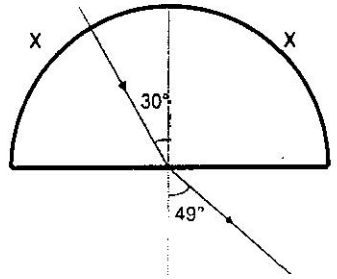

Fig. 10.1

(i) Explain why the ray of light will not undergo total internal reflection if it is incident on anywhere along X. [1]

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(ii) Calculate the critical angle of the glass block in Fig. 10.1. [2]

10. (c) What do you understand by the focal length of a converging lens is 6.0 cm? [1]

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(i) Fig. 10.2, which was drawn to full scale, shows rays from a distant object reaching a converging lens with a focal length of 6.0 cm.
Complete the ray diagram in Fig. 10.2 to show how the converging lens forms an image [3]

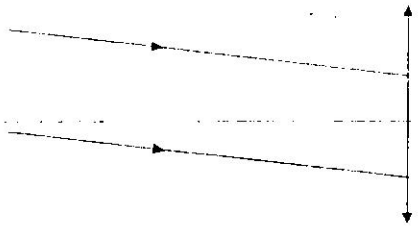

Fig. 10.2

Describe the effect on the image [1]
(ii) as the lens is moved towards the left side.

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(iii) when half of the lens is cut away as shown in Fig. 10.3. [1]

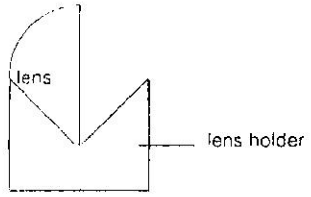

Fig. 10.3

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11. An ignition coil (see Fig. 11.1) is used to produce sparks to ignite fuel in the engine. The ignition coil produces high-voltage pulses from a d.c. supply. An ignition coil consists of a transformer made from two coils of insulated copper wire wound around a common iron core. One wire forms the external primary coil, with the secondary coil wrapped within the primary coil.

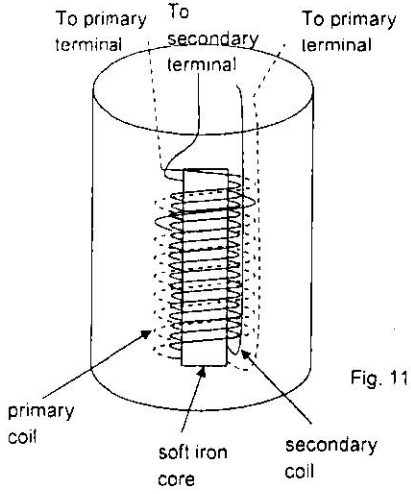

Fig. 11.1

Some information of the device is presented in Fig. 11.2.

Type A	Primary coil	Secondary Coil
Voltage (V)	12	30000
Current (A)		0.050
Number of turns	100	250000

Type B	Primary coil	Secondary Coil
Voltage (V)	36000	12
Current (A)	0.042	
Number of turns	300000	100

Fig. 11.2

(a) Explain why a voltage is developed across the secondary coil when the current in the primary coil is interrupted suddenly. [1]

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(b) State and explain which transformer, Type A or B is suitable as an ignition coil. [2]

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11. (c) The primary voltage (V_P) versus time graph is shown in Fig. 11.3, when t_1 and t_2 are the times when the controlling switch is closed and opened respectively.
Sketch the corresponding secondary voltage (V_S) versus time graph on the given axis [2]

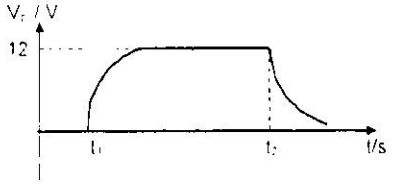
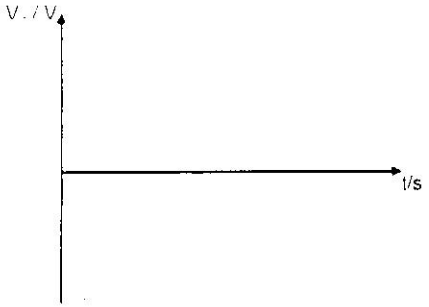


Fig. 11.3



(d) Explain with a reason if the wire used for the primary coil solenoid should be thick or thin [1]

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(e) The secondary winding of an ignition coil is connected as shown in Fig. 11.4 to a light bulb.
Explain why the light bulb did not lit up continously when the switch is closed. [1]

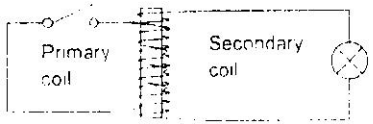

Fig. 11.4

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11. (f) In a set-up to demonstate motional electromotive force, a conducting rod was moved across a magnetic field from right to left in Fig. 11.5. The magnetic field is going perpendicularly into the paper. The rod was sliding on fricitonless metal rails which were linked by connecting wires with crocodile clips.

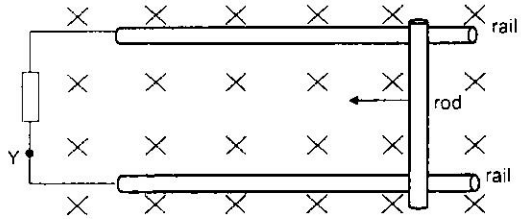

Fig. 11.5

(i) Determine the direction of the current flow in the external circuit by marking an arrow at point Y in Fig 11.5. [1]

(ii) Explain your answer [2]

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12. EITHER

Infrared toasters are considered parts of the modern day convenience in kitchen and food preparations. An infrared toaster, rated at 650 W 230 V, operates through 2 infrared lamps positioned above and below the holding tray (sees Fig. 12.1).

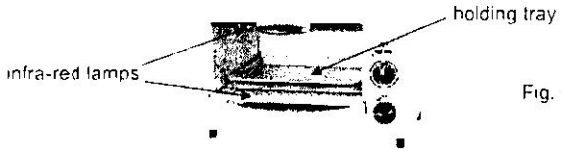

Fig. 12.1

(a) (i) Explain why the interior of the toaster is silver-coloured and smooth. [1]

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(ii) Discuss why the infrared toaster cooks the same quantity and type of food in a shorter time compared to a conventional oven which is much bigger physically [2]

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(iii) Calculate the current drawn when the infrared toaster is switched on. [1]

(b) The insulation of the mains cable has worn away and this causes the live wire to make contact with the outer metal casing of the infrared toaster

(i) Explain the hazard that results if the outer metal casing is not earthed. [1]

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(ii) Explain how connecting the earth wire to the outer metal casing and using a circuit breaker of a suitable rating removes this hazard. [2]

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(b) (iii) Fig. 12.2a and Fig. 12.2b show a circuit breaker before and after it has been activated respectively.

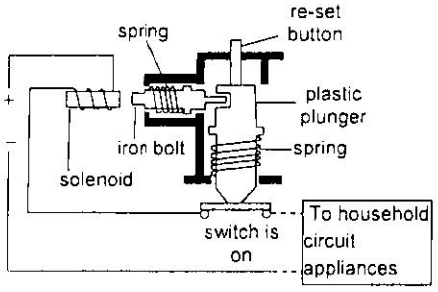

Fig. 12.2a

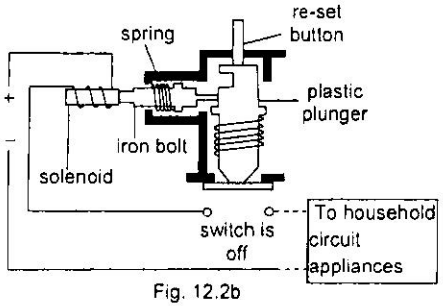

Fig. 12.2b

Referring to Fig. 12.2a and Fig. 12.2b, explain how the circuit breaker works when a fault occurs. [3]

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OR

Fig. 12.3 shows circular wavefronts produced at the centre of a wave pool. Two plastic buoys, A and B, float on the water in the pool. Buoy A is on the crest of a wave at the instant shown.

(a) State the meaning of a wavefront. [1]

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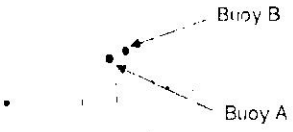

Fig. 12.3

(b) Fig. 12.4 shows a snapshot of the displacement-distance graph of A and B. A wave takes 0.800 s to move from A to B.

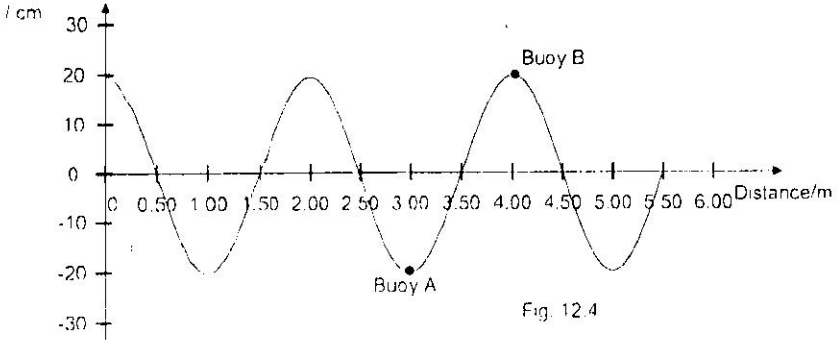

Fig. 12.4

(i) Calculate the frequency of the wave. [2]

(ii) Sketch a displacement–time graph of buoy B, starting from the instant shown in Fig. 12.3. Draw at least 2 cycles in your graph. [2]

(c) A vessel is detecting schools of fish in the ocean. Sonar is used to locate schools of fish and the depth of the seabed in the sea. The sonar sends pulses of ultrasound of frequency 45 kHz from the bottom of the ship to determine the depth of the seabed. The reflected pulses are picked up by a receiver and displayed on a cathode-ray oscilloscope (c.r.o.) as shown in Fig. 12.5. The time-base of the c.r.o. is set to be 50 ms/ div. The speed of the ultrasound in water is known to be 1450 m s^{-1}.

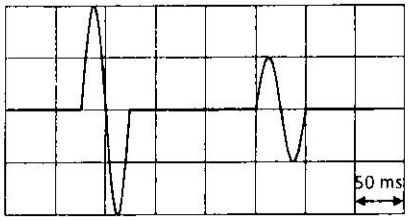

Fig. 12.5

(i) On Fig. 12.5, label the reflected pulse as *R*. Explain your choice. [1]

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(ii) Calculate the wavelength of the ultrasound. [1]

(iii) Determine the depth of the seabed. [2]

(d) If the frequency of the ultrasound is doubled, what is the effect on the speed of the wave? [1]

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End of paper

Marking scheme for Physics Paper1

1	2	3	4	5	6	7	8	9	10
A	B	B	C	A	C	C	C	D	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	A	D	A	D	D	D	A	B	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
C	B	C	A	C	C	B	C	C	B
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	C	C	C	C	C	C	A	D	C

scheme for Physics Paper1

1. (a)Rate of change of displacement. B1

(b) (i) $a = \Delta v / \Delta t = = (-5.6 - 6.0) / 20 \times 10^{-3}$ M1

$= -580\ ms^{-2}$ A1

(ii) $v^2 = u^2 + 2as$, $s = (0^2 - 5.6^2) / 2(-10.0) = 1.568$

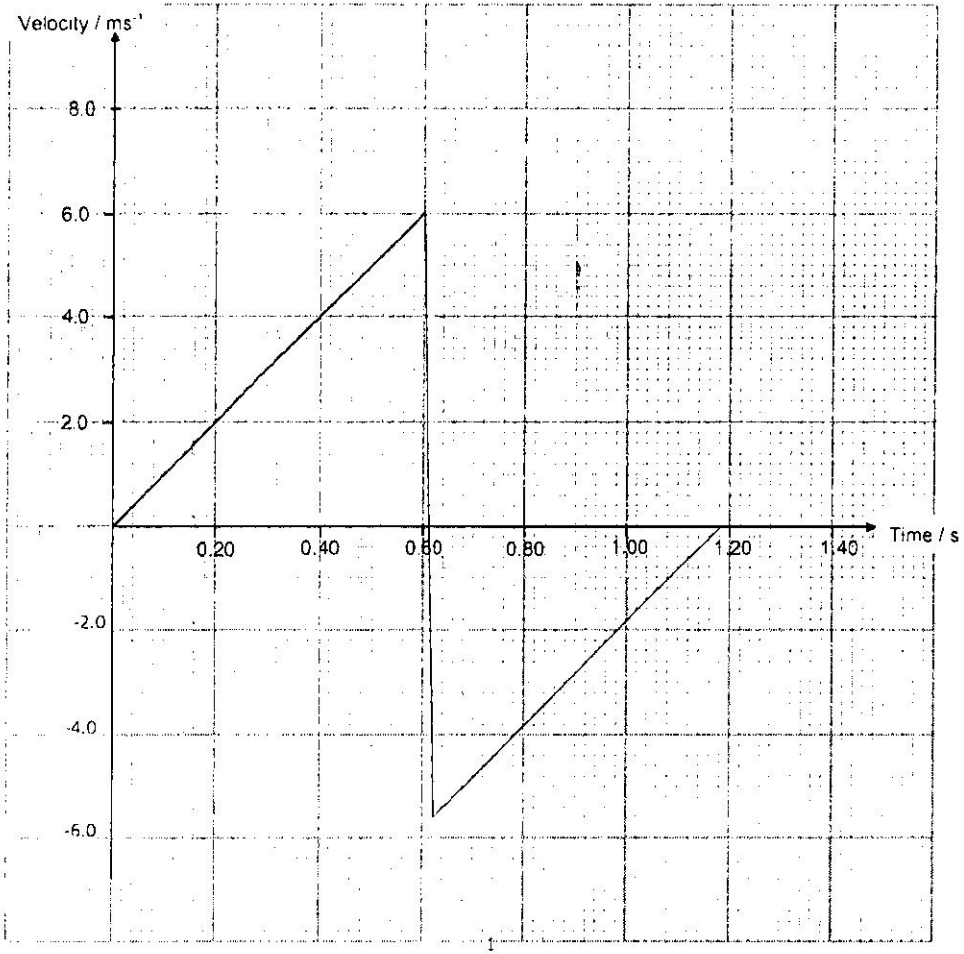
$s = 1.6$ m (2 sf) B1

(iii) $v = u + at$, $t = (0 - 5.6) / (-10.0)$ B1

$t = 0.56$ s (2 sf) A1

(B1may be awarded if student failed to draw any line), allow ecf

B1 for line from (0.60, 6.0) to (0.62 ,-5.6) and B1 for line from (0.62 ,-5.6) to (1.18, 0); without proper marking on axes deduct 1 m



2 (a) Friction = 18 N as slope of the graph gives us velocity of the box. Since the slope of the position time graph is constant, velocity of the box is also constant. As a result, acceleration of the box becomes zero indicating the forces acting on box are balanced.

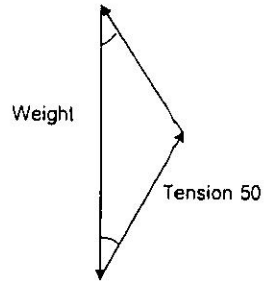
(b) The box starts to accelerate [B1] at $a = (20 - 18) / 4 = 0.50\ ms^{-2}$ (B1 for magnitude).

3(a) It is a point where the entire weight of the object appears to act irrespective of its orientation. [B1]

(b) Scale: 1 cm : 5 N [B1]

Reaction = 44.0 N [B1]

Correct closed triangle [B1]



4 (a) (i) $P = h\rho g$

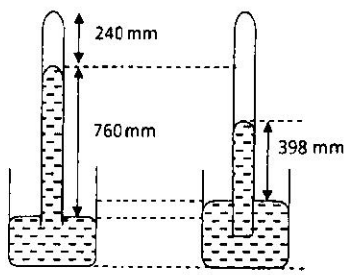
$101000 = h \times (13600) \times 10.0$ [M1]

$h = 0.74265$

$= 0.743$ m [A1]

(ii) To test for a faulty vacuum, incline the tube until its top end is below the horizontal level extended from 0.743 m of the height above the reservoir. If the whole of mercury fills the tube then there is no air trapped inside. [B1]

(b)



$h_{atm}\rho_{air} = h_{Hg}\rho_{Hg}$

$h_{atm}(1.23) = 0.760 \times 13600$

$h_{atm} = 8403.3$ m [B1]

Hence at 4000m height $h_{Hg} = (8403.3 - 4000) / 8403.3 \times 0.760$

$= 0.398$ m Hg (3 sf) [B1]

Drawing [B1]

5(a) Moment = $50 \times 0.10 = 5.0$ Nm [B1]

(b) At P, Pressure $P = F/A = 50.0 / 20.0 = 2.50\ Ncm^{-2}$ [B1]

This pressure is transmitted to Piston Q.

Hence $F_Q = P \times A_Q = 2.50 \times 800 = 2000$ N [B1]

(c) Method 1: work done is same at P and Q,

$F_P \times D_P = 50.0 \times 0.100 = 5.00$ J [B1]

Hence $D_Q = 5.00 / F_Q = 5.00 / 2000 = 2.5 \times 10^{-3}$ m [B1]

OR Method 2: Volume of fluid is conserved

At P volume of fluid pushed downwards, $V = 20.0 \times 10.0 = cm^3$

At Q, rise in height $= V / A_Q = 200 / 800 = 0.250$ cm $= 2.5 \times 10^{-3}$ m

6 (a) Any of the 6 differences Eg no bubbles against bubbles (boiling); boiling occurs at a fixed temperature ... [B1]

(b)(i) The air pressure in the bell jar is lower than atmospheric pressure as less air particles are present now. [B1]

Although the internal work done to overcome forces of attraction between molecules remains unchanged, the external work done against the atmosphere has been reduced significantly. This reduces the amount of PE required by the water particles to vaporise. [B1]

(ii) As the temperature of a substance is directly proportional to its sum of KE, the more energetic molecules still need sufficient energy to **overcome attractive forces** due to other molecules to escape from the surface into the atmosphere. As less energetic molecules are left behind, the **average** kinetic energy of the molecules **decreases** and the temperature **decreases.[B1]**

7(a)(i) Shows convection current in clockwise direction from the sea.
7(a)(ii) Land and the adjacent water body are subjected to the uneven heating during the daytime. The land, which has a low specific heat capacity heats up much more quickly than water. (B1)
As the land warms up, the air next to it heats by conduction and rises. (or first B1 here)
As the warmer air rises by **due to its lower density,** cooler air is drawn from the ocean to fill the void. The warmer air mass returns to sea at higher levels to complete a convective **current.** (need to write different density for second B1)

(b)

(i) Energy given up by the aluminium in cooling to 100°C

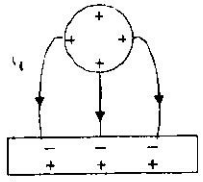
$= mc\ \theta = 3 \times 910 \times (600 - 100) = 1365000$ J. B1

(ii) To heat 2 kg of water from 25°C to 100°C requires $2 \times 4200 \times (100 - 25) = 630000$ J. B1

Available energy for boiling water = 1365000 J – 630000 – 5000 = 730000 J B1

Mass of water boiled away = E/l = 730000 / 2260000 = 0.323 kg. A1

8 (a)



B1 direction

B1 pattern

(b) (i) When the positively charged particles are brought near to the metal, the electrons of the metal part are induced to the surface nearer to the positively charged paint particles. [B1]
Since unlike charges attract, the positively charged particles will be attracted to the electrons of the metal. [B1]
(ii) All paint particles are positively charged of the same amount. [B1]
Since like charges repel, the particles will be repelled away from each other, allowing them to be spread out more uniformly on the metal. [B1]

9 (a) $\rho = RA / l = 48.8 \times [(3.142/4 \times (0.30 \times 10^{-3})^2] / (200)$ M1

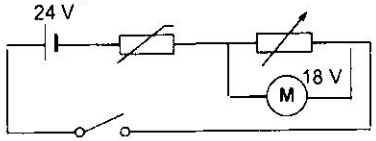
$= 1.73 \times 10^{-8} = 1.7 \times 10^{-8} \Omega m$ A1 (2 sf) check sf here

9 (b) (i) No. When the intensity of light reduces, the resistance of LDR increases but potential **difference across lamp remains unchanged as lamp is connected in parallel.** B1
Current flowing through lamp does not change and therefore the lamp remains lit throughout when the switch is closed. B1

(b) (ii) ammeter reading increases. B1

(c) (i) B1: thermistor drawn in series with variable resistor
B1: motor in parallel with variable resistor

(ii) B1: (When the switch is closed) and temperature rises, the potential difference across the variable resistor would become higher than the thermistor. Hence there is enough pd to drive the motor.



10 (a) (i) The ratio of the speed of light in vacuum to the speed of light in water is 1.33. [B1]

(ii) The ray of light is incident from an optically less dense (rarer) medium to optically denser medium. Hence TIR cannot occur.[B1]

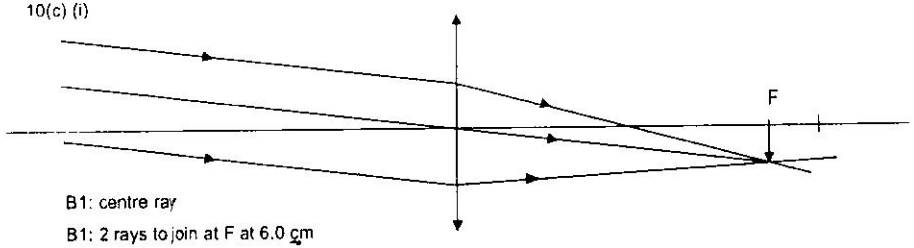
(iii) $n_1 \sin i = n_2 \sin r$

$n_2 = (1) \times \sin 49 / \sin 30 = 1.51$ [B1]

$c = \sin^{-1} (1 / 1.51) = 41.5°$ [B1]

10(b) The distance between the optical centre and principal focus is 6.0 cm

10(c) (i)



B1: centre ray

B1: 2 rays to join at F at 6.0 cm

B1: inverted image at 6.0 cm

10(c)(ii) Image remains unchanged in size. Still inverted. [B1]
(iii) The image becomes less bright, while still being inverted [B1]

11 (a) The change in current in the primary coil sets up changing magnetic flux linkage within the secondary coil and hence induce an emf in it according to Faraday's law of EMI. B1

11(b) Type A. A High output or secondary voltage is required for a spark to be formed.[B1]