Cambridge Assessment International Education

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5197842885

PHYSICS **0625/42**

Paper 4 Theory (Extended) **February/March 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 10 N (acceleration of free fall = 10 m / s^2).

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

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1 A ball rolls down a ramp and onto a horizontal surface. The first section of the horizontal surface is smooth. The second section of the horizontal surface is rough. Fig. 1.1 shows a speed–time graph for the ball.

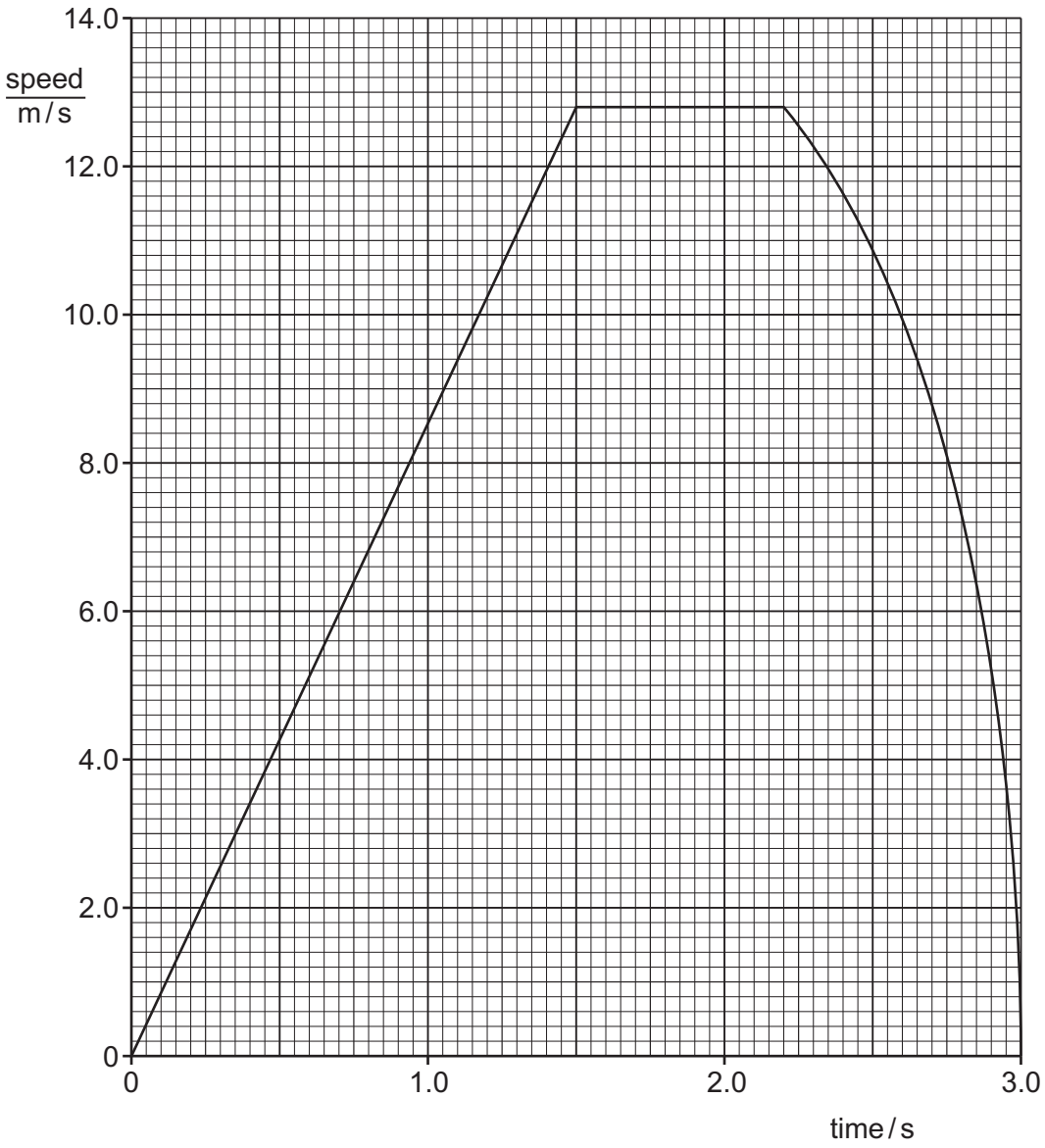


Fig. 1.1

(a) State the time when the ball reaches the start of the rough section of the horizontal surface.

time = ... [1]

(b) Explain how Fig. 1.1 shows that there is **no** resultant force on the ball when it rolls along the smooth section of the horizontal surface.

.....

..... [2]

(c) Using Fig. 1.1, determine the acceleration of the ball as it rolls down the ramp.

acceleration = ... [3]

(d) The ball starts from rest at the top of the ramp.

Show that the length of the ramp is 9.6 m.

[2]

[Total: 8]

2 Fig. 2.1 shows a spring balance used to measure the weight of a baby. The spring inside the balance extends when a mass is suspended from it. The dial shows the extension of spring as a value of mass in kg.

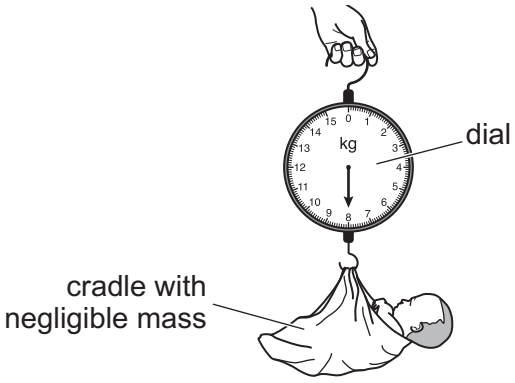


Fig. 2.1

The spring obeys Hooke's law up to a weight of 175 N.

(a) (i) State Hooke's law.

.....

..... [1]

(ii) State the relationship between the mass of the baby and the force exerted on the spring due to the baby.

.....

..... [1]

(iii) The reading on the spring balance is 8.0 kg.

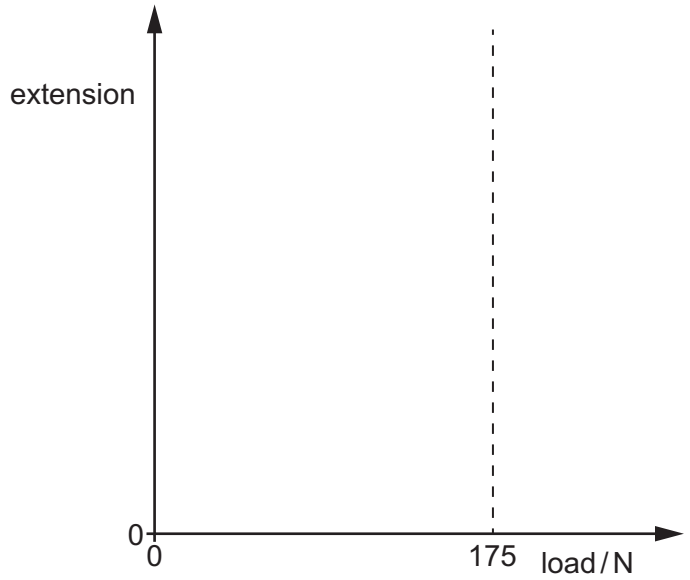
Determine the force exerted on the spring due to the baby.

force = ... [1]

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(b) The limit of proportionality for the spring is at a force of 175 N.

Sketch the extension–load graph for the spring. The sketch must continue beyond a force of 175 N.



[2]

(c) The baby is carried from the ground floor to the bedroom. The vertical height of the bedroom above the ground floor is 3.5 m.

Calculate the change in gravitational potential energy of the baby when it is carried from the ground floor to the bedroom.

change in gravitational potential energy = ... [2]

[Total: 7]

3 Fig. 3.1 and Fig. 3.2 show how a puddle of water changes on a warm windy day.

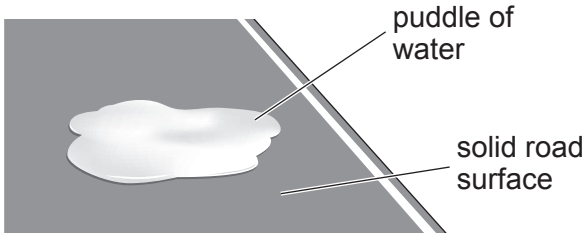


Fig. 3.1

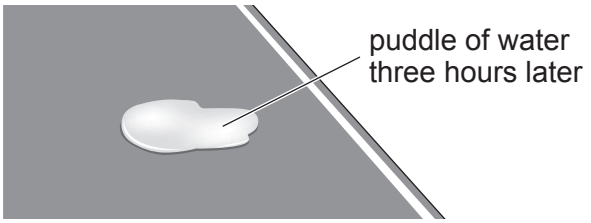


Fig. 3.2

(a) Describe the process by which the volume of water in the puddle decreases.

.....

.....

..... [2]

(b) State and explain **one** change in the weather that would cause the volume of water in the puddle to decrease more slowly.

statement .....

explanation .....

.....

[2]

(c) Explain, in terms of molecules, how sweating helps to cool your body on a hot day.

.....

.....

.....

..... [3]

[Total: 7]

4 **(a)** A sample of sand has a volume of $0.050\,m^3$. The density of the sand is $1900\,kg/m^3$. The specific heat capacity of the sand is $1500\,J/(kg\,°C)$.

(i) Calculate the mass of the sample of sand.

mass = ... [2]

(ii) Calculate the thermal capacity of the sample of sand.

thermal capacity = ... [2]

(iii) The initial temperature of the sample of sand is 7.0 °C. The sample of sand is heated using an electrical heater. The power of the heating element is 50 W.

Calculate the time taken to increase the temperature of the sand to 19.0 °C.

time = ... [3]

(b) In some countries, the soil is too cold for plants to grow well. In these countries, plants are grown in plastic pots and kept inside. The pots, containing soil, are placed on sand. The sand is heated using an electrical heater, as shown in Fig. 4.1.

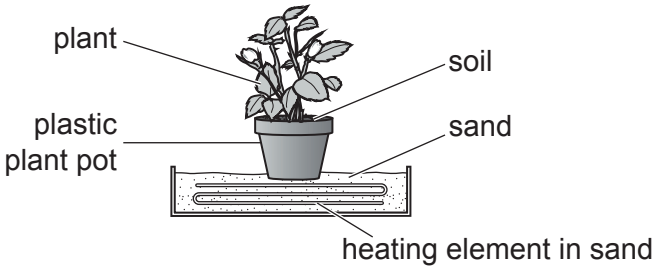


Fig. 4.1

(i) Describe, in terms of molecules, how thermal energy is transferred from the heated sand through the base of the plastic pot.

.....

.....

.....

..... [2]

(ii) The heating element in Fig. 4.1 remains switched on. The temperature of the sand remains constant at a value above room temperature.

Explain why the temperature of the sand remains constant.

.....

.....

..... [2]

[Total: 11]

5 A boy looks at the image of a clock in a plane mirror. Fig. 5.1 shows the mirror, the clock and the position of one of the boy's eyes.

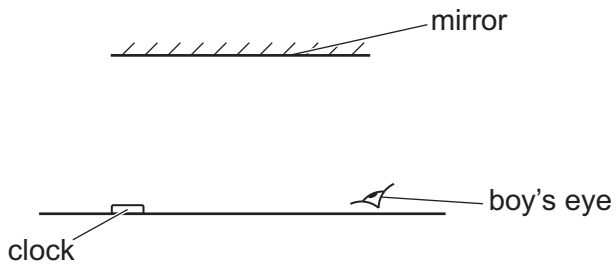


Fig. 5.1

(a) (i) On Fig. 5.1, draw a ray of light from the clock, reflected to the boy's eye. [2]

(ii) On Fig. 5.1, mark with an X the position of the image of the clock. [1]

(iii) State whether the image formed by the mirror is virtual or real.

Explain your answer.

.....

..... [1]

(iv) Fig. 5.2 shows the image of the clock seen by the boy.

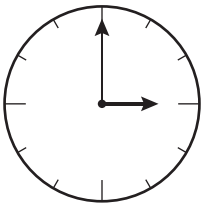


Fig. 5.2

The boy now looks directly at the clock.

On Fig. 5.3, draw what the boy sees.

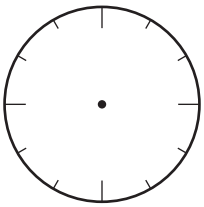


Fig. 5.3

[1]

(b) (i) The clock is illuminated by a source of monochromatic green light.

State the meaning of monochromatic.

..... [1]

(ii) The green light has a wavelength of 5.6×10^{-7} m.

Calculate the frequency of this green light.

frequency = ... [3]

[Total: 9]

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6 Fig. 6.1 shows two bar magnets.



Fig. 6.1

(a) On Fig. 6.1, sketch the pattern and the direction of the magnetic field lines between the bar magnets. [2]

(b) Fig. 6.2 shows the same bar magnets with a coil of wire between them.

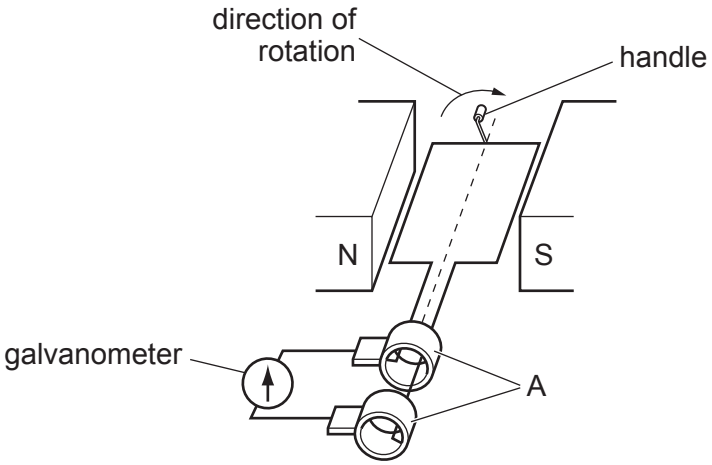


Fig. 6.2

(i) Name the parts labelled A in Fig. 6.2.

..... [1]

(ii) The coil of wire is rotated in the direction shown in Fig. 6.2.

On Fig. 6.2, draw an arrow to show the direction of the current in the coil. Explain your answer.

.....

..... [2]

(iii) Explain how rotating the coil in Fig. 6.2 continuously causes the galvanometer needle to show an alternating current.

.....

.....

.....

.....

..... [4]

[Total: 9]

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7 Fig. 7.1 shows a circuit including a 12 V battery and two identical lamps.

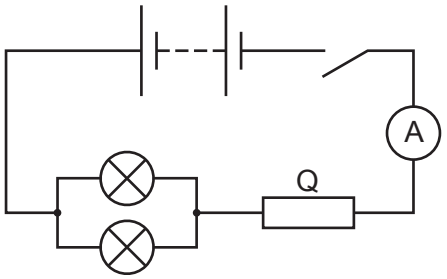


Fig. 7.1

(a) The 12 V battery consists of cells connected in series. Each cell in the battery has an electromotive force (e.m.f.) of 1.5 V.

Determine how many cells are in the battery.

number of cells = ... [1]

(b) (i) When the switch is closed, the ammeter reading is 2.4 A.

Calculate the total resistance of the circuit.

resistance = ... [2]

(ii) Each lamp has a resistance of 3.0 Ω.

Calculate the resistance of Q.

resistance of Q = ... [2]

(c) (i) On Fig. 7.1, draw the symbol for a voltmeter that measures the potential difference (p.d.) across the two lamps. [1]

(ii) Calculate the power supplied to **one** lamp.

power = ... [3]

[Total: 9]

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8 A radio is connected to the mains supply using a step-down transformer.

(a) Draw a labelled diagram of the structure of a basic step-down transformer.

[3]

(b) Explain the operation of a basic transformer.

.....

.....

.....

..... [3]

(c) The voltage of the mains supply is 230 V. The output voltage of the transformer is 6.0 V.

Calculate the value of the turns ratio $(\frac{N_s}{N_p})$. Give your answer to two significant figures.

value of turns ratio = ... [2]

[Total: 8]

9 Fig. 9.1 shows a digital circuit.

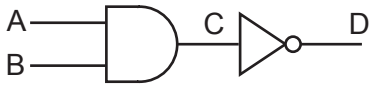


Fig. 9.1

(a) (i) Explain what is meant by digital.

..... [1]

(ii) Table 9.1 is a truth table for the digital circuit shown in Fig. 9.1.

Complete the columns C and D in Table 9.1.

Table 9.1

A	B	C	D
0	0		
0	1		
1	0		
1	1		

[2]

(b) State the single logic gate that would produce the same output D from inputs A and B.

..... [1]

[Total: 4]

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10 The isotope americium-241 is represented by

$$^{241}_{95}\text{Am}.$$

This isotope decays by an α-emission to an isotope of neptunium (Np).

(a) Complete the nuclide equation for this decay.

$$^{241}_{95}\text{Am} \rightarrow \overset{\cdots\cdots}{\underset{\cdots\cdots}{\quad}}\text{Np} + \overset{\cdots\cdots}{\underset{\cdots\cdots}{\quad}}\alpha$$

[3]

(b) Fig. 10.1 shows a simple diagram of a smoke detector. The smoke detector contains a small sample of americium-241. This isotope ionises the air between the metal plates in the detector.

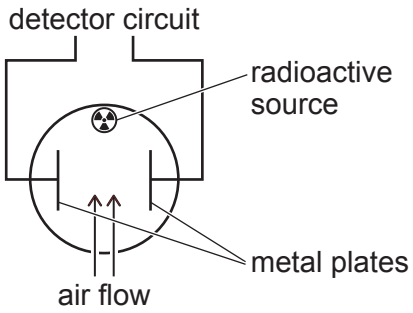


Fig. 10.1

(i) Describe how the americium-241 ionises air.

.....

.....

.....

..... [3]

(ii) Suggest and explain **two** reasons why smoke detectors use an isotope that emits α-particles rather than an isotope that emits γ-radiation.

1. .....

.....

.....

2. .....

.....

.....

[2]

[Total: 8]

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