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Lil	National Qualificati 2016	ons		<u> </u>			Mark	
X757/76/01			S	ecti	on 1 -	— An and	P Iswe Sec	hysics r Grid tion 2
TUESDAY, 24 MAY 9:00 AM – 11:30 AM						* X 7	577	601*
Fill in these boxes and rea	nd what is printed	d below.						
Full name of centre				Town				
Forename(s)	Surn	ame				Nu	umber	of seat
Date of birth Day Month	Year	Scott	ish car	didate	e number			
Total marks — 130				I				
SECTION 1 — 20 marks Attempt ALL questions. Instructions for the compl	etion of Section 1	are give	en on l	Page 0	2.			
SECTION 2 — 110 marks Attempt ALL questions.								
Reference may be made to the Relationships Sheet XI Care should be taken to go calculations. Write your answers clearly and rough work is provide identify the question nu booklet. You should score Use blue or black ink. Before leaving the exame Invigilator; if you do not, you	o the Data Sheet 757/76/11. ive an appropriat y in the spaces p ed at the end of mber you are at through your roug ination room yo you may lose all th	on <i>Page</i> e numb rovided this bo temptin gh work bu must he mark	e 02 of er of s in thio ooklet. ig. Any when give s for th	the q ignific s book If you y roug you ha this I nis pap	uestion p ant figure (let. Addit use this h work r ave writte pooklet to per.	aper X7 es in the tional sp space y must be en your f o the	57/76/ final a pace fo you mu writta inal co	02 and to answers to or answers ust clearly en in this py. SQA
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The questions for Section 1 are contained in the question paper X757/76/02.

Read these and record your answers on the answer grid on Page 03 opposite.

Use **blue** or **black** ink. Do NOT use gel pens or pencil.

- 1. The answer to each question is **either** A, B, C, D or E. Decide what your answer is, then fill in the appropriate bubble (see sample question below).
- 2. There is only one correct answer to each question.
- 3. Any rough work must be written in the additional space for answers and rough work at the end of this booklet.

Sample Question

The energy unit measured by the electricity meter in your home is the:

- A ampere
- B kilowatt-hour
- C watt
- D coulomb
- E volt.

The correct answer is \mathbf{B} — kilowatt-hour. The answer \mathbf{B} bubble has been clearly filled in (see below).



Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



If you then decide to change back to an answer you have already scored out, put a tick (\checkmark) to the **right** of the answer you want, as shown below:











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[Turn over for SECTION 2

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Χ7

*

2. (c) (continued)	MARKS	DO NOT WRITE IN THIS MARGIN	
(ii) Calculate the average force of friction acting between the toy ca and carpet, as the car comes to rest.	r		
An uncertainty in this value is not required.	3		
Space for working and answer			

(iii) State one assumption you have made in (c) (ii).



[Turn over for next question

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- 4. Two physics students are in an airport building on their way to visit CERN.
 - (a) The first student steps onto a moving walkway, which is travelling at $0.83 \,\mathrm{m\,s^{-1}}$ relative to the building. This student walks along the walkway at a speed of $1.20 \,\mathrm{m\,s^{-1}}$ relative to the walkway.

The second student walks alongside the walkway at a speed of $1.80 \,\mathrm{m\,s^{-1}}$ relative to the building.



Determine the speed of the first student relative to the second student. 2 Space for working and answer



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5. (a) A student is using an elastic band to model the expansion of the Universe.



One end of the band is fixed in a clamp stand at V. Knots are tied in the band to represent galaxies. The knots are at regular intervals of 0.10 m, at points W, X and Y as shown.



The other end of the elastic band is pulled slowly for 2.5 seconds, so that the band stretches. The knots are now in the positions shown below.



5. (a) (continued)

(i) Complete the table to show the average speeds of the knots X and Y. 2

Knot	Average speed (m s ⁻¹)		
W	0.008		
Х			
Y			

Space for working

(ii) Explain why this model is a good simulation of the expansion of the Universe.

1

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7. An experiment is set up to investigate the behaviour of electrons in electric fields.



(a) Electrons are accelerated from rest between the cathode and the anode by a potential difference of $2 \cdot 0 \text{ kV}$.

Calculate the kinetic energy gained by each electron as it reaches the anode.

Space for working and answer

(b) The electrons then pass between the two parallel metal plates.

The electron beam current is 8.0 mA.

Determine the number of electrons passing between the metal plates in one minute.

Space for working and answer



MARKS DO NOT

3

4

THIS

MARKS DO NOT WRITE IN THIS MARGIN 7. (continued) (c) The switch S is now closed. The potential difference between the metal plates is 250 V. The path of the electron beam between the metal plates is shown. + 250 V path of electron beam 0 V Complete the diagram to show the electric field pattern between the two metal plates. 1 (An additional diagram, if required, can be found on Page 38.) [Turn over

X 7

57760121*

8. The diagram shows part of an experimental fusion reactor.



The following statement represents a reaction that takes place inside the reactor.

$${}_{1}^{2}H + {}_{1}^{3}H \rightarrow {}_{2}^{4}He + {}_{0}^{1}n$$

The masses of the particles involved in the reaction are shown in the table.

Particle	Mass (kg)
² ₁ H	3·3436 × 10 ^{−27}
³ ₁ H	5·0083 × 10 ^{−27}
⁴ ₂ He	6∙6465 × 10 ⁻²⁷
¹ ₀ n	1·6749 × 10 ^{−27}

- (a) Explain why energy is released in this reaction.
- (b) Calculate the energy released in this reaction. *Space for working and answer*



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1









10. Retroflective materials reflect light to enhance the visibility of clothing.

One type of retroflective material is made from small glass spheres partially embedded in a silver-coloured surface that reflects light.

A ray of monochromatic light follows the path shown as it enters one of the glass spheres.

embedded in a silver-coloured surface that reflects light.

air glass sphere

(a) Calculate the refractive index of the glass for this light. *Space for working and answer*

normal

36

ray of

light

3







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11. A student is describing how the following circuit works.



The student states:

"The electricity comes out of the battery with energy and flows through the resistor using up some of the energy, it then goes through the LED and the rest of the energy is changed into light waves."

Use your knowledge of physics to comment on this statement.



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MARKS DO NOT WRITE IN THIS MARGIN 12. (continued) (b) Some cars use LEDs in place of filament lamps. An LED is made from semiconductor material that has been doped with impurities to create a p-n junction. The diagram represents the band structure of an LED. conduction band band gap 00000 ()valence band \cap p-type n-type (i) A voltage is applied across an LED so that it is forward biased and emits light. Using **band theory**, explain how the LED emits light. 3



 (ii) The energy gap between the valence band and conduction band is known as the band gap. The band gap for the LED is 3.03 × 10⁻¹⁹ J (A) Calculate the wavelength of the light emitted by the LED. 4 <i>Space for working and answer</i> (B) Determine the colour of the light emitted by the LED. 1 	Γ	12. (b) (co	ntinı	ued)		MARKS	DO NOT WRITE IN
The band gap for the LED is 3.03×10^{-19} J 4 (A) Calculate the wavelength of the light emitted by the LED. 4 Space for working and answer 1 (B) Determine the colour of the light emitted by the LED. 1 [Turn over] [Turn over]			(ii)	The knov	energy gap between the valence band and conduction band is vn as the band gap.	;	MARGIN
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(B) Determine the colour of the light emitted by the LED. 1 [Turn over				(A)	Calculate the wavelength of the light emitted by the LED.	4	
(8) Determine the colour of the light emitted by the LED. 1					Space for working and answer		
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13. A technician sets up a circuit as shown.



The power supply has negligible internal resistance.

(a) The capacitor is initially uncharged.

The switch is moved to position P and the capacitor charges.

- (i) State the potential difference across the capacitor when it is fully charged.
- (ii) Calculate the maximum energy stored by the capacitor. Space for working and answer

* X 7 5 7 7 6 0 1 3 2 *

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1

13. (continued)						
(b) The switch is now moved back to position Q. Determine the maximum discharge current in the circuit. Space for working and answer	3					
 (c) The technician replaces the 150 mF capacitor with a capacitor capacitance 47 mF. The switch is moved to position P and the capacitor is fully charged. The switch is now moved to position Q. State the effect that this change has on the time the lamp stays lit. You must justify your answer. 	of 2					

[Turn over for next question



MARKS DO NOT WRITE IN THIS MARGIN A student investigates the factors affecting the frequency of sound produced 14. by a vibrating guitar string. The guitar string is stretched over two supports and is made to vibrate as shown. guitar string support pulley not to scale masses The frequency *f* of the sound produced by the vibrating string is given by the relationship $f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$ T is the tension in the string where L is the distance between the supports μ is the mass per unit length of the string. (a) The tension in the string is 49.0 N and the mass per unit length of the string is $4.00 \times 10^{-4} \text{ kg m}^{-1}$. The distance between the supports is 0.550 m. Calculate the frequency f of the sound produced. 2 Space for working and answer



14. (continued)

(b) The guitar string in part (a) is replaced by a different guitar string.

A student varies the tension T and measures the frequency f of the sound produced by the new guitar string.

<i>T</i> (N)	\sqrt{T} (N ^{1/2})	<i>f</i> (Hz)
10	3.2	162
15	3.9	190
20	4.5	220
25	5.0	254
30	5.2	273

The student records the following information.

- (i) Using the square-ruled paper on Page 36, draw a graph of f against \sqrt{T}
- (ii) Use your graph to determine the frequency of the sound produced when the tension in the guitar string is 22 N.

1

3

[END OF QUESTION PAPER]













ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ACKNOWLEDGEMENT

Section 2 Question 10 – Image of Reflective Safety Jacket, taken from <u>http://www.tradeget.</u> <u>com/listing/sri-balaji-associates/product-services-detail-62668/18652/1/1</u>).

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