Neap

HSC Trial Examination 2020

Physics

General Instructions	• Reading time – 5 minutes • Working time – 3 hours • Write using black pen • Draw diagrams using pencil • Calculators approved by NESA may be used • A data sheet, formulae sheets and Periodic Table are provided at the back of this paper
Total marks: 100	**Section I – 20 marks** (pages 2–6) • Attempt Questions 1–20 • Allow about 35 minutes for this section **Section II – 80 marks** (pages 7–24) • Attempt Questions 21–37 • Allow about 2 hours and 25 minutes for this section

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2020 HSC Physics Examination.

Section I

20 marks
Attempt Questions 1–20
Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

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1. To move against a gravitational field, work is required to be done.

What is this form of energy often referred to as?

(A) Newton's Laws of Gravitation
(B) gravitational potential energy
(C) kinetic energy
(D) Kepler's Laws

2. What is the name of the process whereby an atom changes into a different element?

(A) transmutation
(B) orbital decay
(C) the quantum model
(D) wave-particle duality

3. Which of the following sentences correctly describes the relationship between mass, radius and centripetal force?

(A) A large mass results in more centripetal force, and a large radius results in more centripetal force.
(B) A large mass results in more centripetal force, and a large radius results in less centripetal force.
(C) A large mass results in less centripetal force, and a large radius results in more centripetal force.
(D) A large mass results in less centripetal force, and a large radius results in less centripetal force.

4. What does the stator in a DC motor provide?

(A) a location for the current to enter within the DC motor
(B) a magnetic field either via permanent magnets or electromagnets
(C) constant connection between the rotating armature and the external circuit
(D) maximum resistance within a wire

5. Which of the following is NOT one of the six quarks proposed by scientists?

(A) charm
(B) strange
(C) bottom
(D) upper

6. The surface temperature of the star Betelgeuse is 3500 K.

What is the peak wavelength of Betelgeuse's radiation?

(A) 502 nm
(B) 818 nm
(C) 823 nm
(D) 828 nm

7. Which of the following correctly describes Lenz's Law?

(A) An induced current flows in a direction such that its own magnetic field attracts the changing magnetic field that caused it.
(B) An induced current flows in a direction such that its own magnetic field opposes the changing magnetic field that caused it.
(C) Induced emf is always proportional to the rate of change of the magnetic flux.
(D) Induced emf is always inversely proportional to the rate of change of the magnetic flux.

8. At a nuclear facility in Germany, 129 g of fuel was converted to energy.

What is the mass–energy equivalence of 129 g of matter?

(A) 3.87×10^{7} J
(B) 4.49×10^{15} J
(C) 1.16×10^{16} J
(D) 2.24×10^{16} J

9. A current-carrying conductor is 92 mm long and experiences a force of 1.84 N when placed at a right angle to a magnetic field.

What is the magnetic flux density when 3.6 amps of current are passed through the conductor?

(A) 5.56×10^{-3} T
(B) 5.16 T
(C) 5.56 T
(D) 6.09 T

10. At the beginning of the Big Bang, energy was converted into particles.

Which of the following particles would NOT have been present within the first 100 seconds of the beginning of the Big Bang?

(A) helium
(B) quarks
(C) protons
(D) antiprotons

11. What is the wavelength of a bowling ball with a mass of 5 kg travelling at 12.6 m s^{-1}?

(A) 3.78×10^{-35} m
(B) 1.05×10^{-35} m
(C) 2.14×10^{-34} m
(D) 1.55×10^{-34} m

12. Which of the following is a consequence of the law of conservation of energy?

(A) magnetic braking
(B) incomplete flux linkage
(C) AC generator
(D) magnetic flux density

13. When gaseous atoms have an electrical current passed through them, they can produce light. Gaseous atoms absorb electrical energy, and then their electrons transition from ground state to a higher energy state. Later, the electrons can return to ground state. As electrons return to ground state, they release light; this light is particular to atoms of a particular element.

What is observed when an electron moves from a higher energy state to ground state?

(A) absorption spectra
(B) continuous spectra
(C) radioactive decay
(D) emission spectra

14. A cannonball is launched at 49 m s^{-1}. It reaches a maximum height of 105 m above its origin.

To the nearest degree, what is the angle of elevation required to reach this height?

(A) 45°
(B) 58°
(C) 68°
(D) 93°

15. A race-car travelling at 300 km h^{-1} drives around a race-track corner with radius 750 m. The road of the race track is designed so that car tyres do not experience any friction.

To the nearest degree, at what angle is the road banked?

(A) 13°
(B) 23°
(C) 33°
(D) 43°

16. The work function for tungsten is 4.5 eV.

What is the minimum wavelength of radiating photons that will have this threshold energy?

(A) 4.42×10^{-16} m
(B) 2.74×10^{-9} m
(C) 1.76×10^{-7} m
(D) 2.76×10^{-7} m

17. Spectroscopy allows scientists to study stars.

What type of spectral lines are produced by low-density stellar atmospheres?

(A) sharper, narrower spectral lines
(B) broadening spectral lines
(C) sharper spectral lines that are slightly shifted towards the red end of the spectrum
(D) sharper spectral lines that are slightly shifted towards the blue end of the spectrum

18. The planet Venus has a mass of 4.87×10^{24} kg and a diameter of 12 100 km.

What is the value of acceleration due to gravity on the surface of Venus?

(A) 8.87 m s^{-2}
(B) 9.86 m s^{-2}
(C) 9.89 m s^{-2}
(D) 10.13 m s^{-2}

19. When uranium-235 is hit with a neutron, it absorbs it and then splits according to the following nuclear equation:

$$ {}^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{139}_{56}Ba + {}^{94}_{36}Kr + 3\,{}^{1}_{0}n + \text{energy} $$

During this reaction, there is a loss of mass of 3.60×10^{-28} kg.

What is the amount of energy released during the fission of a single uranium-235 atom?

(A) 112 MeV
(B) 186 MeV
(C) 194 MeV
(D) 202 MeV

20. A proton is circulating inside the ring of a synchrotron. The proton has an orbital radius of 82 m and a velocity of 1.25×10^{8} m s^{-1}.

What is the magnitude of the magnetic field required to keep the proton in orbit?

(A) 0.0175 T
(B) 0.0185 T
(C) 0.0188 T
(D) 0.0196 T

Section II

80 marks
Attempt Questions 21–37
Allow about 2 hours and 25 minutes for this section

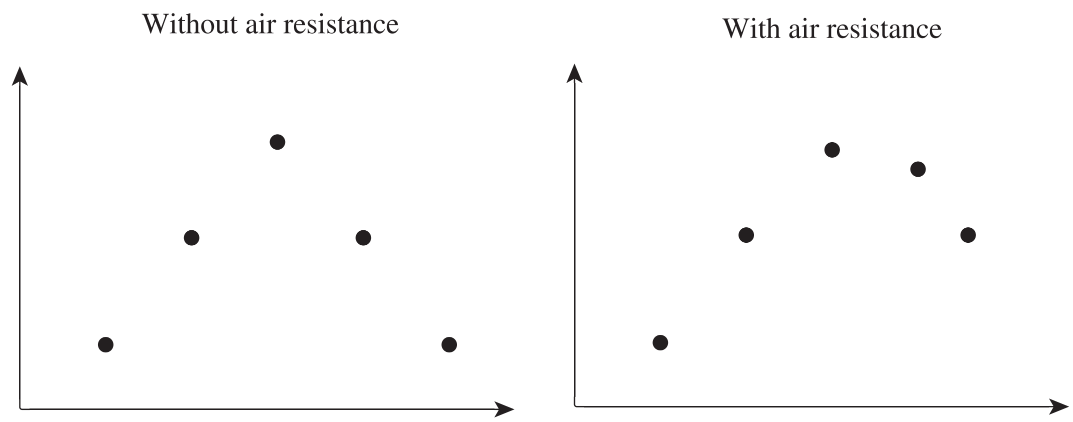
Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

Question 21 (4 marks)

A group of students analysed the effects of air resistance on projectile motion. The same experiment was performed twice – firstly in an evacuated chamber without air resistance, and then in the classroom with air resistance. The following graphs obtained from the results of both experiments show the paths taken by two identical projectiles. **4**



Discuss the effects of air resistance on the individual projectiles. In your answer, describe how the graphs demonstrate these effects.

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Question 22 (4 marks)

On a class excursion, a student with a mass of 65 kg rides a merry-go-round. They are 4.4 m from the centre of rotation. Once the student reaches maximum speed, the class records the time it takes for the student to complete three revolutions. They record the time as 78 s.

(a) What is the student's linear speed? **2**

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(b) What is the student's angular velocity? **1**

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(c) What is the centripetal force acting on the student? **1**

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Question 23 (6 marks)

(a) Describe Kepler's Second Law of equal areas. Include a labelled diagram in your answer. **3**

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(b) Derive Kepler's Third Law of periods. **3**

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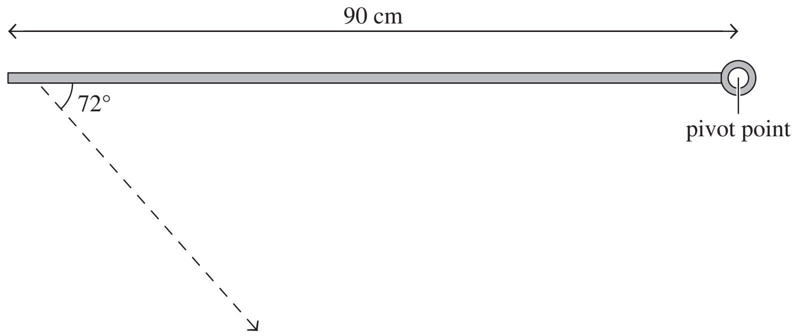
Question 24 (2 marks)

A student opens their classroom door as seen in the diagram. The dashed arrow shows the direction from which the door is pulled. **2**



How much force does the student apply to open the door if the total torque is 31 Nm?

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Question 25 (4 marks)

During your Year 12 Physics course, you will have completed an investigation of historical and contemporary methods used to determine the speed of light. **4**

Discuss ONE historical and ONE contemporary method used to determine the speed of light.

Question 26 (3 marks)

A monochromatic neon lamp with a wavelength of 854 nm was used to demonstrate diffraction. When the light from the lamp was shone through vertical parallel slits, an interference pattern was produced on a screen 2.5 metres away. The slits were recorded to be 0.200 mm apart.

(a) Determine the angle of the first-order maximum. **2**

(b) Calculate the distance on the screen between the first-order maximum and the central maximum. **1**

Question 27 (8 marks)

A group of scientists at Australia's Nuclear Science and Technology Organisation (ANSTO) collected data on the decay of a radioactive isotope. Their results are shown in the following table.

Time (hours)	*Recorded mass (g)*
0	100
4	72.0
8	50.0
12	34.0
16	25.0
20	17.0
24	12.5
28	8.00
32	6.25

(a) Graph the results on the grid provided. **3**

(b) Determine the half-life of the isotope. **1**

Question 27 continues on page 13

Question 27 (continued)

(c) A sample of another radioactive isotope was investigated by the same group of scientists. This sample was found to have a half-life of 16 hours.

(i) Calculate the decay constant of the isotope sample. **2**

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(ii) What percentage of the sample will be left undecayed after two days? **2**

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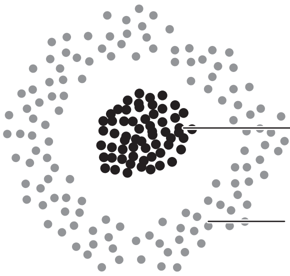
End of Question 27

Question 28 (4 marks)

Discuss the early experiments that examined the nature of cathode rays AND their role in the discovery of the electron. **4**

Question 29 (8 marks)

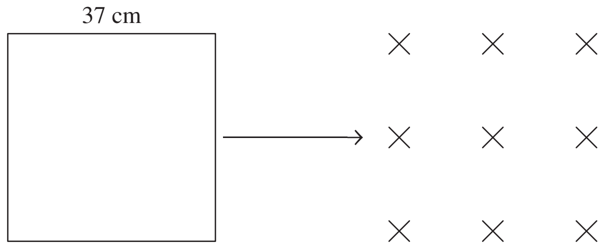
The atomic model has continually been changed and improved due to scientific advancements. It has been influenced by many scientists. The image below is the model suggested by Edwin Schrödinger. This model is often referred to as the quantum model of the atom. **8**



Explain how the atomic model changed over time and led to the model proposed by Schrödinger.

Question 30 (5 marks)

The diagram below shows a square single loop entering a perpendicular magnetic field of 0.80 T. The square loop takes 0.04 seconds to enter the magnetic field.



(a) What is the magnitude of induced emf in the square loop? **4**

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(b) What direction does the induced current flow in the square loop? **1**

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Question 31 (4 marks)

A typical DC motor can produce 10–7000 revolutions per minute.

(a) Identify TWO modifications that would increase the speed of a DC motor. **2**

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(b) Outline the role of a commutator in a DC motor. **2**

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Question 32 (4 marks)

Compare the effects of electric and magnetic fields on a charged particle if the particle is initially moving perpendicular to the fields. Support your answer with a labelled diagram showing each field. **4**

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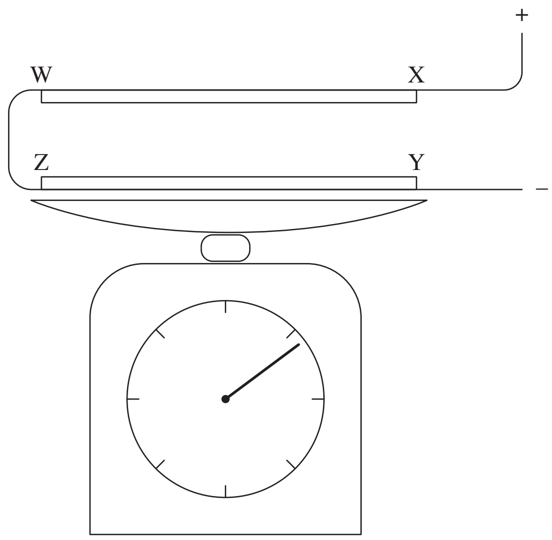
Question 33 (4 marks)

A teacher demonstrates the forces on two parallel identical copper conductors, as shown in the diagram. **4**



The top conductor WX is fixed, while the bottom conductor ZY lies on top of a balance. The distance between the conductors is 5 mm, and each conductor is 29 cm in length. Initially, the balance reads 4.5 grams for conductor ZY. When the current is switched on, the teacher records a reading of 4.56 grams.

Calculate the magnitude of the current.

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Question 34 (3 marks)

As an in-depth study, a group of students tested different transformers to calculate their efficiency. The students supplied a transformer with 0.02 Amps at 240 V and recorded the output of the transformer as 0.28 Amps at 12 V. **3**

Calculate the efficiency of the transformer AND account for the loss of energy.

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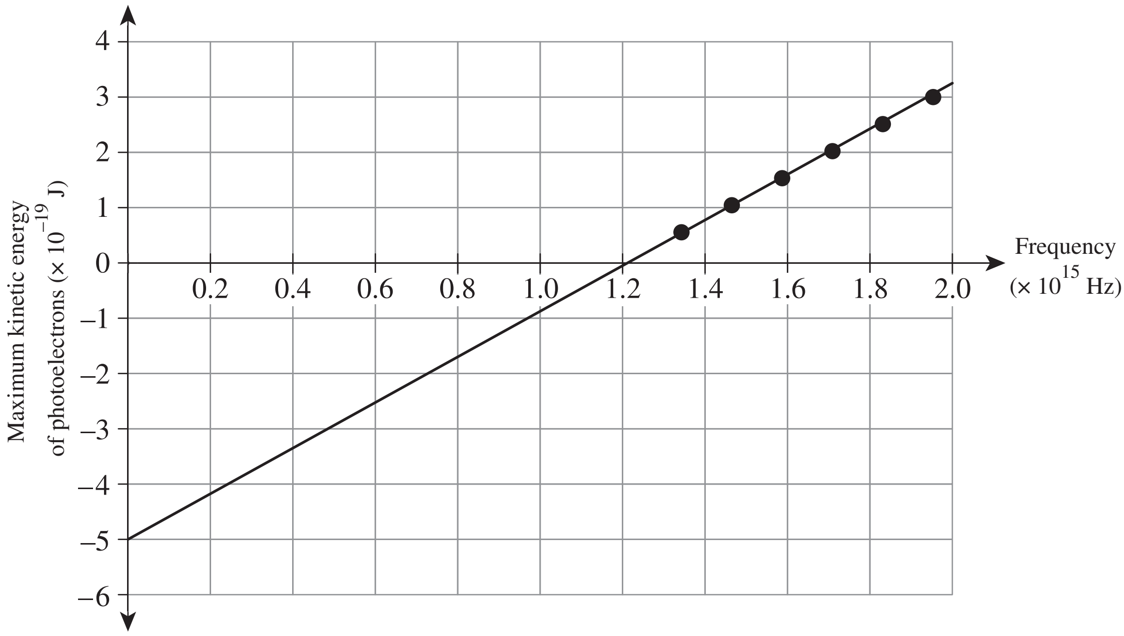
Question 35 (7 marks)

Ultraviolet light with a wavelength of 180 nm is shone on a polished nickel plate. The work function for the nickel plate is shown in the graph.



(a) What is the work function for the nickel plate? **1**

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(b) What is the kinetic energy of the fastest-moving electrons? **3**

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Question 35 continues on page 21

Question 35 (continued)

(c) Demonstrate the cut-off frequency of the nickel plate mathematically AND through interpretation of the graph. **3**

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End of Question 35

Question 36 (3 marks)

The National Aeronautics and Space Administration (NASA) recently sent a space probe to a newly discovered, potentially habitable planet 20 light years away. The space probe will travel at a velocity of 0.38 c to get there.

(a) Calculate how long the journey will take. **1**

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(b) The scientists placed an atomic clock on board the space probe to measure the duration of the journey. **2**

According to the atomic clock on board the space probe, calculate how long the journey will take.

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Question 37 (7 marks)

A satellite with a mass of 2550 kg is orbiting the Earth at an altitude of 35 800 km above the Earth's surface.

(a) Calculate the total mechanical energy of the satellite. **2**

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(b) Calculate the speed of the satellite. **3**

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(c) Identify the type of satellite that orbits at this altitude AND describe TWO uses of this type of satellite. **2**

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Section II extra writing space

If you use this space, clearly indicate which question you are answering.

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

Data sheet

Charge on electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^{8} m s^{-1}
Electric permittivity constant, ε_0	8.854×10^{-12} A^2 s^4 kg^{-1} m^{-3}
Magnetic permeability constant, μ_0	$4\pi \times 10^{-7}$ N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth, M_E	6.0×10^{24} kg
Radius of Earth, r_E	6.371×10^{6} m
Planck constant, h	6.626×10^{-34} J s
Rydberg constant, R (hydrogen)	1.097×10^{7} m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^{3} kg m^{-3}
Specific heat capacity of water	4.18×10^{3} J kg^{-1} K^{-1}
Wien's displacement constant, b	2.898×10^{-3} m K

Formulae sheet

Motion, forces and gravity	
$s = ut + \frac{1}{2}at^2$	$v = u + at$
$v^2 = u^2 + 2as$	$\vec{F}_{\text{net}} = m\vec{a}$
$\Delta U = mg\Delta h$	$W = F_{\parallel}s = Fs\cos\theta$
$P = \frac{\Delta E}{\Delta t}$	$K = \frac{1}{2}mv^2$
$\sum \frac{1}{2}mv^2_{\text{before}} = \sum \frac{1}{2}mv^2_{\text{after}}$	$P = F_{\parallel}v = Fv\cos\theta$
$\Delta\vec{p} = \vec{F}_{\text{net}}\Delta t$	$\sum m\vec{v}_{\text{before}} = \sum m\vec{v}_{\text{after}}$
$\omega = \frac{\Delta\theta}{t}$	$a_{\text{c}} = \frac{v^2}{r}$
$\tau = r_{\perp}F = rF\sin\theta$	$F_{\text{c}} = \frac{mv^2}{r}$
$v = \frac{2\pi r}{T}$	$F = \frac{GMm}{r^2}$
$U = -\frac{GMm}{r}$	$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$

Waves and thermodynamics	
$v = f\lambda$	$f_{\text{beat}} = \lvert f_2 - f_1 \rvert$
$f = \frac{1}{T}$	$f' = f\frac{(v_{\text{wave}} + v_{\text{observer}})}{(v_{\text{wave}} - v_{\text{source}})}$
$d\sin\theta = m\lambda$	$n_1\sin\theta_1 = n_2\sin\theta_2$
$n_{\text{x}} = \frac{c}{v_{\text{x}}}$	$\sin\theta_{\text{c}} = \frac{n_2}{n_1}$
$I = I_{\max}\cos^2\theta$	$I_1{r_1}^2 = I_2{r_2}^2$
$Q = mc\Delta T$	$\frac{Q}{t} = \frac{kA\Delta T}{d}$

Formulae sheet (continued)

Electricity and magnetism

$$E = \frac{V}{d}$$

$$\vec{F} = q\vec{E}$$

$$V = \frac{\Delta U}{q}$$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$W = qV$$

$$I = \frac{q}{t}$$

$$W = qEd$$

$$V = IR$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$P = VI$$

$$B = \frac{\mu_0 NI}{L}$$

$$F = qv_\perp B = qvB\sin\theta$$

$$\Phi = B_\parallel A = BA\cos\theta$$

$$F = lI_\perp B = lIB\sin\theta$$

$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$$

$$\frac{F}{l} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r}$$

$$\frac{V_\mathrm{p}}{V_\mathrm{s}} = \frac{N_\mathrm{p}}{N_\mathrm{s}}$$

$$\tau = nIA_\perp B = nIAB\sin\theta$$

$$V_\mathrm{p} I_\mathrm{p} = V_\mathrm{s} I_\mathrm{s}$$

Quantum, special relativity and nuclear

$$\lambda = \frac{h}{mv}$$

$$t = \frac{t_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$K_{\max} = hf - \phi$$

$$l = l_0\sqrt{\left(1 - \frac{v^2}{c^2}\right)}$$

$$\lambda_{\max} = \frac{b}{T}$$

$$p_\mathrm{v} = \frac{m_0 v}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$E = mc^2$$

$$N_\mathrm{t} = N_0 e^{-\lambda t}$$

$$E = hf$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_\mathrm{f}^2} - \frac{1}{n_\mathrm{i}^2}\right)$$

$$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$$

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79
Symbol	**Au**
Standard Atomic Weight	197.0
Name	Gold

1 **H** 1.008 Hydrogen																	2 **He** 4.003 Helium
3 **Li** 6.941 Lithium	4 **Be** 9.012 Beryllium											5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 22.99 Sodium	12 **Mg** 24.31 Magnesium											13 **Al** 26.98 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.97 Phosphorus	16 **S** 32.07 Sulfur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.87 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.69 Nickel	29 **Cu** 63.55 Copper	30 **Zn** 65.38 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 72.64 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.61 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.96 Molybdenum	43 **Tc** Technetium	44 **Ru** 101.1 Ruthenium	45 **Rh** 102.9 Rhodium	46 **Pd** 106.4 Palladium	47 **Ag** 107.9 Silver	48 **Cd** 112.4 Cadmium	49 **In** 114.8 Indium	50 **Sn** 118.7 Tin	51 **Sb** 121.8 Antimony	52 **Te** 127.6 Tellurium	53 **I** 126.9 Iodine	54 **Xe** 131.3 Xenon
55 **Cs** 132.9 Caesium	56 **Ba** 137.3 Barium	57–71 Lanthanoids	72 **Hf** 178.5 Hafnium	73 **Ta** 180.9 Tantalum	74 **W** 183.9 Tungsten	75 **Re** 186.2 Rhenium	76 **Os** 190.2 Osmium	77 **Ir** 192.2 Iridium	78 **Pt** 195.1 Platinum	79 **Au** 197.0 Gold	80 **Hg** 200.6 Mercury	81 **Tl** 204.4 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 209.0 Bismuth	84 **Po** Polonium	85 **At** Astatine	86 **Rn** Radon
87 **Fr** Francium	88 **Ra** Radium	89–103 Actinoids	104 **Rf** Rutherfordium	105 **Db** Dubnium	106 **Sg** Seaborgium	107 **Bh** Bohrium	108 **Hs** Hassium	109 **Mt** Meitnerium	110 **Ds** Darmstadtium	111 **Rg** Roentgenium	112 **Cn** Copernicium	113 **Nh** Nehonium	114 **Fl** Flerovium	115 **Mc** Moscovium	116 **Lv** Livermorium	117 **Ts** Tennessine	118 **Og** Oganesson

Lanthanoids

57 **La** 138.9 Lanthanum	58 **Ce** 140.1 Cerium	59 **Pr** 140.9 Praseodymium	60 **Nd** 144.2 Neodymium	61 **Pm** Promethium	62 **Sm** 150.4 Samarium	63 **Eu** 152.0 Europium	64 **Gd** 157.3 Gadolinium	65 **Tb** 158.9 Terbium	66 **Dy** 162.5 Dysprosium	67 **Ho** 164.9 Holmium	68 **Er** 167.3 Erbium	69 **Tm** 168.9 Thulium	70 **Yb** 173.1 Ytterbium	71 **Lu** 175.0 Lutetium

Actinoids

89 **Ac** Actinium	90 **Th** 232.0 Thorium	91 **Pa** 231.0 Protactinium	92 **U** 238.0 Uranium	93 **Np** Neptunium	94 **Pu** Plutonium	95 **Am** Americium	96 **Cm** Curium	97 **Bk** Berkelium	98 **Cf** Californium	99 **Es** Einsteinium	100 **Fm** Fermium	101 **Md** Mendelevium	102 **No** Nobelium	103 **Lr** Lawrencium

Standard atomic weights are abridged to four significant figures. Elements with no reported values in the table have no stable nuclides. Information on elements with atomic numbers 113 and above is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (November 2016 version). The International Union of Pure and Applied Chemistry Periodic Table of the Elements (Febuary 2010 version) is the principal source of all other data. Some data may have been modified

Neap

HSC Trial Examination 2020

Physics

Solutions and marking guidelines

Section I

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 1 **B** Newton's Laws of Gravitation are related to two bodies with space and the forces related. Kinetic energy and Kepler's Laws are not associated nor involve work within their equations or theory. The only plausible answer is **B**, which is the work to place an object in space against gravity or within space.	Mod 5 Advanced Mechanics PH12–12 Bands 2–3
Question 2 **A** Orbital decay refers to satellite motion, and the quantum model refers to atomic theory. Wave-particle duality refers to light, leaving **A** as the only plausible answer. Transmutation is the decay of one element into another.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3
Question 3 **B** This is related to $Fc = \frac{mv^2}{r}$. The larger the mass, the more centripetal force; however, with a large radius there is less centripetal force.	Mod 5 Advanced Mechanics PH12–12 Bands 2–3
Question 4 **B** The stator within a DC motor is the stationary component of the motor. The permanent magnets or electromagnets remain stationary and provide a magnetic field, and the armature or coil rotates.	Mod 6 Electromagnetism PH12–13 Bands 2–3
Question 5 **D** Charm, strange and bottom are all quarks, while upper is not.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3
Question 6 **D** $\lambda_{\text{max}} = \frac{b}{T}$ $= \frac{2.898 \times 10^{-3}}{3\,500 \text{ K}}$ $= 828 \text{ nm}$	Mod 7 The Nature of Light PH12–14 Bands 3– 4
Question 7 **B** Lenz's Law states that the induced current will always flow in a direction such that the resultant magnetic field opposes the original magnetic field. All other responses do not describe Lenz's Law.	Mod 6 Electromagnetism PH12–13 Bands 3–4
Question 8 **C** $E = mc^2$ $= 0.129 \times (3.00 \times 10^8)^2$ $= 1.16 \times 10^{16} \text{ J}$	Mod 7 The Nature of Light PH12–14 Bands 3–4
Question 9 **C** $B = \frac{F}{I_L \sin\theta}$ $= \frac{1.84}{3.6 \times 92 \times 10^{-3} \times \sin 90}$ $= 5.56 \text{ T}$	Mod 6 Electromagnetism PH12–13 Bands 3– 4

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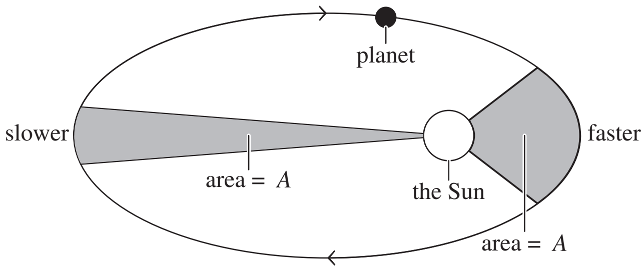
Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 10 **A** Within the first 100 seconds of the beginning of the Big Bang, all the fundamental particles were present, which includes options **B**, **C** and **D**. Helium was made after hydrogen formed, which was well past the first 100 seconds.	Mod 8 From the Universe to the Atom PH12–15 Bands 3–4
Question 11 **B** $\lambda = \frac{h}{mv}$ $= \frac{6.626 \times 10^{-34}}{5 \times 12.6}$ $= 1.05 \times 10^{-35}$ m	Mod 8 From the Universe to the Atom PH12–15 Bands 3–4
Question 12 **A** Incomplete flux linkage and magnetic flux density are not consequences of the conservation of energy, so **B** and **D** are incorrect. AC generators do not operate by the laws of conservation of energy, so **C** is incorrect. Magnetic braking is the cause of eddy currents generated by the conservation of energy.	Mod 6 Electromagnetism PH12–13 Bands 3–4
Question 13 **D** When an electron moves from a higher energy state to a lower state, it emits a photon. This phenomenon is often referred to as emission spectra.	Mod 7 The Nature of Light PH12–14 Bands 3–4
Question 14 **C** $\sin\theta = \sqrt{\frac{2gh}{u^2}}$ $\sin\theta = \sqrt{\frac{2 \times 9.8 \times 105}{49^2}}$ $\sin\theta = 0.92582$ $\theta = \sin^{-1}0.92582$ $= 67°\ 48'$ $\approx 68°$	Mod 5 Advanced Mechanics PH12–12 Bands 4–5
Question 15 **D** $\tan\theta = \frac{v^2}{gr}$ $\tan\theta = \frac{\left(\frac{300}{3.6}\right)^2}{9.8 \times 750}$ $\theta = \tan^{-1}0.94482$ $= 43°\ 23'$ $\approx 43°$	Mod 5 Advanced Mechanics PH12–12 Bands 4–5

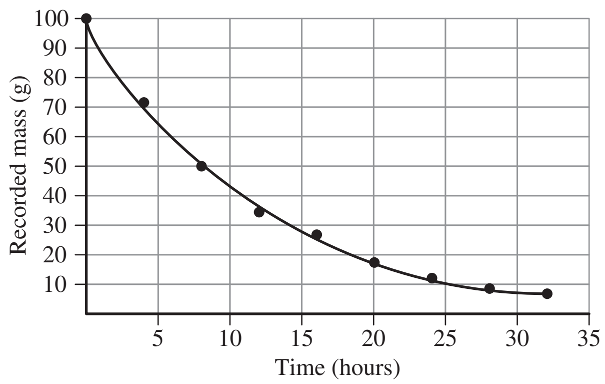
Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 16 **D** $E_{k\,max} = hf - \phi$ $0 = hf - 4.5$ $f = \frac{4.5}{4.14 \times 10^{-15}}$ $= 1.09 \times 10^{15}$ Hz $\lambda = \frac{c}{f}$ $= \frac{3.0 \times 10^{8}}{1.09 \times 10^{15}}$ $= 2.76 \times 10^{-7}$ m	Mod 7 The Nature of Light PH12–14 Bands 4–5
Question 17 **A** Low-density stellar atmospheres produce a bright, narrow line on the emission spectrum or a dark line on the absorption line. The only plausible answer is **A**.	Mod 8 From the Universe to the Atom PH12–15 Bands 4–5
Question 18 **A** $g = \frac{GM}{r^2}$ $= \frac{6.67 \times 10^{-11} \times 4.87 \times 10^{24}}{(6\,050\,000)^2}$ $= 8.87$ m s^{-2}	Mod 5 Advanced Mechanics PH12–12 Bands 4–5
Question 19 **D** $E = mc^2$ $= 3.60 \times 10^{-28} \times (3.0 \times 10^{8})^2$ $= 3.24 \times 10^{-11}$ J E MeV $= \frac{3.24 \times 10^{-11}}{1.602 \times 10^{-19}}$ $= 202$ MeV	Mod 8 From the Universe to the Atom PH12–15 Bands 5–6

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 20 **A** At a speed of 1.25×10^8 m s^{-1}, relativistic effects will take effect and the mass of the proton will dilate. The relativistic mass of the proton will therefore be: $m = \dfrac{m_0}{\sqrt{1 - \dfrac{v^2}{c^2}}}$ $= \dfrac{1.673 \times 10^{-27}}{\sqrt{1 - \dfrac{(1.25 \times 10^8)^2}{(3.0 \times 10^8)^2}}}$ $= 1.840 \times 10^{-27}$ kg Thus: $B = \dfrac{mv}{qr}$ $= \dfrac{1.840 \times 10^{-27} \times 1.25 \times 10^8}{1.602 \times 10^{-19} \times 82}$ $= 0.0175$ T	Mod 6 Electromagnetism PH12–13 Bands 5–6

Section II

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 21	
Air resistance is prevalent in projectile motion, especially when conducting practical investigations. Air resistance or drag that acts on a projectile can be described with the following: • The greater the velocity of the projectile, the greater the air resistance or drag force. • The design of the projectile can have two effects. If the cross-sectional area is greater, or the shape of the projectile is not streamlined, then the air resistance or drag force is greater. • The higher the air density, the greater the drag on the projectile. The graphs clearly demonstrate that one or more of the effects described above had an impact on the flight path recorded. The experiment was conducted the same in both the evacuated chamber and the classroom, meaning that the projectile was the same. Therefore, the graphs show that it was the air resistance in the classroom that changed the flight path of the projectile.	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Describes all the effects of air resistance AND relates it to the diagrams. 4 • Describes all the effects of air resistance. . . . . 3 • Describes some effects of air resistance. OR • States ONE relation to the graphs. . . . . . . 2 • Gives some correct information 1
Question 22	
(a) $\frac{78}{3} = 26$ seconds per revolution $v = \frac{2\pi r}{T}$ $= \frac{2\pi \times 4.4}{26}$ $= 1.1 \text{ m s}^{-1}$	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Calculates time for ONE revolution. AND • Calculates the correct linear speed . . . . . . 2 • Any ONE of the above points. 1
(b) $w = \frac{2\pi}{T}$ $= \frac{2\pi}{26}$ $= 0.24 \text{ rad s}^{-1}$	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Calculates the correct angular velocity. . . 1
(c) $F_c = \frac{mv^2}{r}$ $= \frac{65 \times 1.1^2}{4.4}$ $= 18 \text{ N}$	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Calculates the correct centripetal force. . . 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 23	
(a) The Second Law of Kepler's Laws of Planetary Motion describes the speed of a planet orbiting the Sun. Kepler stated that the line between the Sun and the planet sweeps equal areas in equal times, meaning the speed of the planet increases as it nears the Sun and decreases as it moves away from the Sun. 	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • States Kepler's Second Law. AND • Provides an accurate diagram to support Kepler's Second Law . . . . 3 • Any ONE of the above points . . . . 2 • Gives some correct information. 1
(b) Equate $F_c = \frac{mv^2}{r}$ and $F = \frac{GMm}{r^2}$. $\frac{mv^2}{r} = \frac{GMm}{r^2}$ $v^2 = \frac{GM}{r}$ Let T = the period of orbit to complete one revolution. $v = \frac{2\pi r}{T}$, substitute $v^2 = \frac{GM}{r}$ $\left(\frac{2\pi r}{T}\right)^2 = \frac{GM}{r}$ $\frac{4\pi^2 r^2}{T^2} = \frac{GM}{r}$ Hence $\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$ Or $\frac{r^3}{T^2} = k$	Mod 5 Advanced Mechanics PH12–12 Bands 4–5 • Relates circular motion AND orbital velocity to derive Kepler's law. AND • Demonstrates manipulation of equations to find solution. AND • Correctly derives Kepler's Third Law . . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1
Question 24	
$\tau = rF\sin\theta$ $F = \frac{\tau}{r\sin\theta}$ $= \frac{31}{0.9 \times \sin 72}$ $= 36$ N	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Correctly manipulates torque equation to find force. AND • Calculates the correct force . . . . 2 • Any ONE of the above points 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 25	
For example: In the early 1600s, Galileo attempted to discover the speed of light. He stood on a hilltop and had an assistant stand on a separate hilltop, having measured the distance between the two hills. Both participants had a lamp, and Galileo also had a timepiece. Galileo uncovered his lamp and begin to keep time; when his assistant saw the light from Galileo's lamp, they uncovered their lamp. Galileo recorded the time until he saw the light from his assistant's lamp. By doing so, he was able to determine that the speed of light was ten times greater than the speed of sound. Foucault improved the calculation of the speed of light by using a similar apparatus to that used in Fizeau's method. Foucault shone a bright light through a rotating mirror that would block the light's path. Foucault observed the light hitting a plane surface 8 km away from the rotating mirror and was able to determine the speed of light based on the speed of rotation of the mirror, which periodically blocked the light from hitting the observed surface. His method determined the speed of light to be 298 000 km s^{-1}.	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Discusses ONE historical method used to determine the speed of light. AND • Provides the historical speed of light. AND • Discusses ONE contemporary method used to determine the speed of light. AND • Provides the contemporary speed of light. . . . . 4 • Any THREE of the above points . . . . 3 • Any TWO of the above points . . . . 2 • Any ONE of the above points. 1
Question 26	
(a) $d\sin\theta = m\lambda$ $\theta = \sin^{-1}\left(\frac{m\lambda}{d}\right)$ $= \sin^{-1}\left(\frac{1 \times 854 \times 10^{-9}}{2.00 \times 10^{-4}}\right)$ $= 0.245°$	Mod 7 The Nature of Light PH12–14 Bands 5–6 • Correctly manipulates SI units. AND • Calculates correct first-order maximum . . 2 • Any ONE of the above points. 1
(b) distance $= L\tan\theta$ $= 2.5 \times \tan 0.2446$ $= 0.011$ m	Mod 7 The Nature of Light PH12–14 Bands 5–6 • Calculates correct distance between maximums 1
Question 27	
(a) 	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3 • Gives correct labels and units. AND • Uses correct scale. AND • Correctly plots data with line of best fit . . 3 • Any TWO of the above points . . . . 2 • Any ONE of the above points. 1
(b) Either reading from the table or the graph, the half-life for the isotope is 8 hours.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3 • States correct half-life value 1

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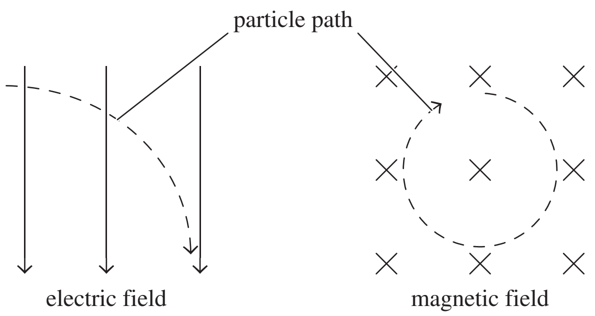
Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(c) (i) 16 hours × 60 × 60 = 57 600 seconds $\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$ $= \frac{\ln 2}{57\,600}$ $= 1.20 \times 10^{-5}\ s^{-1}$	Mod 8 From the Universe to the Atom PH12–15 Bands 4–6 • Calculates the correct decay constant . . . 2 • Gives some correct information. 1
(ii) $n = \frac{48 \text{ hours}}{16 \text{ hours}}$ $= 3$ percentage of sample left undecayed $= \left(\frac{1}{2}\right)^3$ $= \frac{1}{8} = 0.125$ $= 12.5\%$	Mod 8 From the Universe to the Atom PH12–15 Bands 4–6 • Determines the correct percentage of the sample left undecayed . . . . 2 • Gives some correct information. 1
Question 28	
Cathode ray tubes, or discharge tubes, were invented in the mid-1800s by a scientist named Heinrich Geissler. They were invented after the vacuum pump was developed. The vacuum pump was crucial in the development of cathode ray tubes as it created extremely low pressures. This led to the discovery of the electron. Cathode rays were discovered by electrodes being inserted into these vacuum tubes and high voltages being applied. This led scientists to discover and investigate the properties of cathode rays. A variety of different cathode ray tubes were made, which improved the scientists' understanding of the nature of cathode rays. A particular cathode ray experiment demonstrated that cathode rays can be influenced by both electric and magnetic fields. This led scientists such as JJ Thomson to use cathode ray tubes to discover the electron. Thomson deflected a beam of cathode rays with electric fields in order to measure the charge-to-mass ratio of the cathode rays. He called the particles that he discovered electrons. Without the discovery of the vacuum pump, cathode ray tubes would have not been able to be produced, which in turn would have affected the discovery of the electron.	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Discusses how the vacuum pump led to the invention of cathode ray tubes. AND • Discusses the structure of a typical cathode ray tube. AND • Discusses the discovery of cathode rays. AND • Links cathode ray discovery to discovery of the electron . . . . 4 • Any THREE of the above points . . . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 29	
JJ Thomson's discovery of the electron led him to propose the plum pudding model of the atom. This model shows that there is a positively charged fluid with electrons scattered inside this fluid, just as plums are scattered in a plum pudding mixture. Many years after Thomson's discovery, scientists such as Rutherford, Geiger and Marsden found that firing alpha particles at a thin foil of gold produced a scattering of those particles. Rutherford then proposed a planetary model of the atom. This model shows that there is a positive centre (nucleus) and electrons orbiting the nucleus, similar to planets orbiting around the Sun. Rutherford also described a particle that was similar to a proton that would be found inside the nucleus. He predicted that this particle would be neutrally charged. Chadwick submitted a scientific paper many years later called the 'Possible Existence of a Neutron'. Chadwick conducted experiments based on measurements of the recoil of hydrogen and nitrogen after interactions with his proposed neutron. He calculated the neutron's mass to be 1.15 times greater than the proton. Bohr used ideas from previous scientists in developing his model of the atom through the quantum ideas proposed by Planck and Einstein. Bohr described orbital shells/states that electrons occupy and how the movement of electrons between the shells/states must meant energy is being absorbed or emitted. This was the first leap from classical physics to quantum physics. It was further improved by de Broglie, who suggested that electrons may demonstrate wave-like properties. After de Broglie's contribution, the next contributions were from Heisenberg and Schrödinger, two scientists prominent in quantum physics. Heisenberg's uncertainty principle states that, for an electron, its velocity and its position cannot be exactly measured concurrently. Schrödinger then used Heisenberg's uncertainty principle to describe the position of electrons to be in a cloud around the nucleus, where the exact position of an electron can only be known as a probability within this cloud.	Mod 8 From the Universe to the Atom PH12–15 Bands 5–6 • Discusses Thomson's model. AND • Discusses Rutherford's model. AND • Discusses discovery of the neutron. AND • Discusses Chadwick's discovery of the neutron. AND • Discusses Bohr's contribution. AND • Discusses de Broglie's contribution. AND • Discusses Heisenberg's uncertainty principle. AND • Discusses Schrödinger's contribution . . . 8 • Any SEVEN of the above points . . . . 7 • Any SIX of the above points . . . . 6 • Any FIVE of the above points . . . . 5 • Any FOUR of the above points . . . . 4 • Any THREE of the above points . . . . 3 • Any TWO of the above points . . . . 2 • Any ONE of the above points. 1
Question 30	
(a) $\varepsilon = -n\dfrac{\Delta\theta}{\Delta t} = -n\dfrac{\Delta BA}{\Delta t}$ $\lvert\varepsilon\rvert = n\dfrac{\Delta BA}{\Delta t}$ $= 1 \times \dfrac{0.80 \times 0.37^2}{0.04}$ $= 2.74\ \text{V}$	Mod 6 Electromagnetism PH12–13 Bands 4–5 • Calculates the area of the loop. AND • Calculates the change in flux. AND • States the direction of the change in flux. AND • Calculates the correct induced emf/voltage . . . . 4 • Any THREE of the above points . . . . 3 • Any TWO of the above points . . . . 2 • Any ONE of the above points. 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(b) The change in flux is into the page. The direction of the induced magnetic field will be out of the page, meaning the direction of the induced current will be anticlockwise.	Mod 6 Electromagnetism PH12–13 Bands 2–3 • Correctly identifies direction of the induced current 1
Question 31	
(a) *Any two of:* • increasing the force acting on the sides • increasing the width of the coil • adding more coils around the armature • any other reasonable answer	Mod 6 Electromagnetism PH12–13 Bands 2–3 • Gives TWO modifications to increase speed . . . . 2 • Gives ONE modification to increase speed 1
(b) In a DC motor, as the coil rotates in one direction, the current flowing through the loop must reverse direction just as the coil reaches the position where it is perpendicular to the direction of the magnetic field. A commutator, which acts as a switch, is used to reverse the direction of the current. Each part of the commutator is connected to each end of the coil. When the commutator rotates with the coil, contact with the brushes changes just as the coil reaches the position where the plane of the coil is perpendicular to the field direction. This reverses the direction of the current in the coil. As a result, the direction of the force on each side of the coil is reversed and the loop continues to rotate in the same direction.	Mod 6 Electromagnetism PH12–13 Bands 2–3 • Outlines how the commutator interacts with the direction of the current in the coil. AND • Outlines how the commutator interacts with the direction of the force in the coil . . . . 2 • Any ONE of the above points 1
Question 32	
Both electric and magnetic fields exert force on a charged particle. The difference between the effect that electric and magnetic fields have on a charged particle has to do with the particle's trajectory. An electric field exerts a force on a charged particle that is directed in the same direction as the field. A magnetic field exerts a force moving across the field, so the force will be directed perpendicularly to the field and the velocity of the charged particle. This will result in the different trajectories; an electric field will produce a parabolic trajectory, whereas a magnetic field will produce a circular trajectory. This is shown in the following diagrams:  	Mod 6 Electromagnetism PH12–13 Bands 4–5 • States ONE similarity between magnetic and electric fields. AND • States that the trajectories of particles in electric and magnetic fields are different. AND • States that different forces are applied. AND • Draws correct diagrams to show the different trajectories. . . . . 4 • Any THREE of the above points . . . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 33	
force of repulsion = mg $= 0.06 \times 10^{-3} \times 9.8$ $= 5.88 \times 10^{-4}$ N $\frac{F}{l} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r}$ $I = \sqrt{\frac{F \times 2\pi r}{l \times \mu_0}}$ Since the current is the same for both conductors, the magnitude of the current will be: $I = \sqrt{\frac{5.88 \times 10^{-4} \times 2\pi \times 5.00 \times 10^{-3}}{29.0 \times 10^{-2} \times 4\pi \times 10^{-7}}}$ $= 7.12$ A	Mod 6 Electromagnetism PH12–13 Bands 3–4 • Calculates the correct force of repulsion. AND • Rearranges equation to find current. AND • States that the current is the same for both conductors. AND • States the correct magnitude of the current. 4
	• Any THREE of the above points 3
	• Any TWO of the above points 2
	• Any ONE of the above points. 1
Question 34	
input power = $V_1 I_1$ $= 240 \times 0.02$ $= 4.8$ W output power = $V_2 I_2$ $= 12 \times 0.28$ $= 3.36$ W efficiency = $\frac{3.36}{4.8} \times 100$ $= 70\%$ The efficiency is 70%, with losses potentially resulting from eddy currents, wind resistance or flux leakage.	Mod 8 From the Universe to the Atom PH12–15 Band 1 • Calculates the correct input power AND output power. AND • Calculates the correct efficiency AND • Gives an account for energy loss 3
	• Any TWO of the above points 2
	• Any ONE of the above points. 1
Question 35	
(a) $\phi = 5.1$ eV *Note: As the answer is read from the graph, allow responses in the range of 5.1–5.3.*	Mod 7 The Nature of Light PH12–14 Bands 4–6 • Gives response obtained from reading the graph 1
(b) $\lambda = 180$ nm $\phi = 5.1$ eV *Note: ϕ value is dependant on answer to part (a).* $K_{max} = hf - \phi$ $= (4.14 \times 10^{-15} \times 1.25 \times 10^{14}) - 5.1$ $= 0.075$ eV	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Identifies correct equation to calculate K_{max}. AND • Demonstrates working with correct values. AND • Provides correct answer between 0.03–0.075 eV 3
	• Any TWO of the above points 2
	• Any ONE of the above points. 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(c) $\varnothing = hf_0$ $f_0 = \frac{\varnothing}{h}$ $= \frac{5.10}{4.14 \times 10^{-15}}$ $= 1.23 \times 10^{15}$ Hz From the graph, the line of best fit cuts the x-intercept at approximately 1.25×10^{15} Hz, which supports the answer given above.	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Identifies correct equation to calculate cut-off frequency. AND • Supports answer with evidence from the graph. AND • Gives answer between $1.23–1.26 \times 10^{15}$ Hz . . . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1
Question 36	
(a) $t_{\text{Earth}} = \frac{s}{v}$ $= \frac{20}{0.38}$ $= 52.6$ $= 53$ years	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Calculates correct number of years 1
(b) $l_0 = 20$ light years $v_0 = 0.38c$ $l = l_0 \sqrt{1 - \frac{v_0^2}{c_0^2}}$ $= 20 \sqrt{1 - \frac{0.38^2}{1^2}}$ $= 18.5$ light years $t_{\text{atomic clock}} = \frac{s}{v}$ $= \frac{18.5}{0.38}$ $= 48.7$ years	Mod 7 The Nature of Light PH12–14 Bands 4–5 • Calculates correct number of years. AND • Correctly converts light years into Earth years . . . . 2 • Any ONE of the above points 1
Question 37	
(a) $r = 35\,800\,000 + 6\,371\,000$ $= 42\,171\,000$ $E = -\frac{GMm}{2r}$ $= -\frac{6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times 2550}{2 \times 42\,171\,000}$ $= -1.210 \times 10^{10}$ J	Mod 5 Advanced Mechanics PH12–12 Bands 4–5 • Identifies correct equation. AND • Gives the correct answer in joules . . . . . . 2 • Any ONE of the above points 1

<table>
<tr><th></th><th>Sample answer</th><th>Syllabus content, outcomes, targeted performance bands and marking guide</th></tr>
<tr><td rowspan="3">(b)</td><td rowspan="3">$$k = \frac{GMm}{2r}$$
$$= \frac{6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times 2550}{2 \times 42\ 171\ 000}$$
$$= 1.210 \times 10^{10}\ \text{J}$$
$$k = \frac{1}{2}mv^2$$
$$\therefore 1.210 \times 10^{10}\ \text{J} = \frac{1}{2}mv^2$$
$$v^2 = 9\ 490\ 196.078$$
$$v = 3081\ \text{m s}^{-1}$$</td><td>Mod 5 Advanced Mechanics
PH12–12 Bands 4–5
• Identifies relationship between kinetic energy and total mechanical energy from part (a).
AND
• Demonstrates working for calculating kinetic energy.
AND
• Calculates the correct answer . . . . 3</td></tr>
<tr><td>• Any TWO of the above points . . . . 2</td></tr>
<tr><td>• Any ONE of the above points. . . . . 1</td></tr>
<tr><td rowspan="2">(c)</td><td rowspan="2">Geostationary satellites orbit within this range (35 000–36 000 km) away from Earth. A geostationary satellites use is generally specific to one of the following:
• communication
• GPS
• military uses
• weather predictions
Note: Only two uses required for full marks.</td><td>Mod 5 Advanced Mechanics
PH12–12 Band 2–3
• Gives correct satellite type.
AND
• Gives TWO uses of geostationary satellites . . . . 2</td></tr>
<tr><td>• Any ONE of the above points. . . . . 1</td></tr>
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