InspirED

PHYSICS
HSC Simulated Exam

General Instructions
- Reading time – 5 minutes
- Working time – 3 hours
- Write using a black pen
- Draw diagrams using pencil
- For questions in Section II, show all relevant working in questions involving calculations
- NESA approved calculators may be used

Total Marks – 100
- Section I – 20 marks
  - Attempt Questions 1-20
  - Allow about 35 mins for this section
- Section II – 80 marks
  - Attempt Questions 21 – 39
  - Allow about 2 hours and 25 minutes for this section

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

_____

1. A ball is thrown at an angle of 30° and lands 30 m away. A second ball is thrown at the same velocity at an angle of 60°.
   Which of the following statements is true?

   a. The ball lands at 30 m.
   b. It lands further away than 30 m.
   c. The ball lands closer than 30 m.
   d. Not enough information to determine.

2. A pendulum is rotating with a frequency of 1.5 Hz with a radius of 5 cm, as shown below.

5 cm
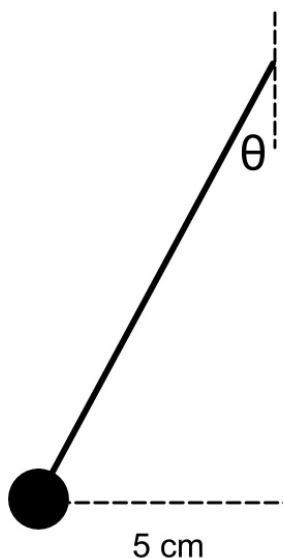
What is the value of θ ?

   a. 0.45°
   b. 16.8°
   c. 24.4°
   d. 45.3°

3. When examining the motion of planets around the sun, it was shown that the ratio of the (radius)^3 to that of the (period)^2 is a constant.
   Who was responsible for discovering this relationship?

   a. Newton
   b. Kepler
   c. Galileo
   d. Einstein

4. Two moons are in orbit around planet X. Moon A has a mass of M and is a radius of R. Moon B has a mass of 2M and a radius of 3M.
   What is the ratio of the gravitational force experienced by Moon B to that of Moon A $F_B : F_A$?

   a. $3 : 2$
   b. $2 : 3$
   c. $9 : 2$
   d. $2 : 9$

5. A satellite is placed in a circular orbit as shown. It is then moved to a higher orbit.
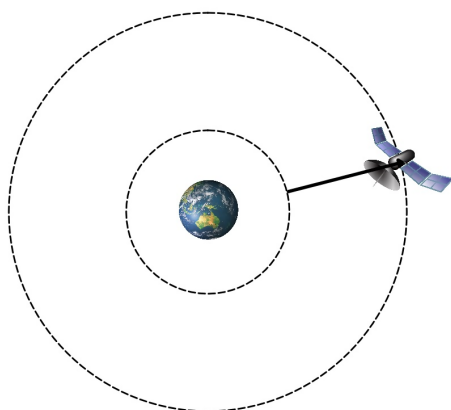
   What happens to its velocity and total energy?

	velocity	energy
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

6. An electron passes through an electric field and magnetic field, as seen below.

   5 mT

   X X X X X X
   X X X X X X

   1000 V
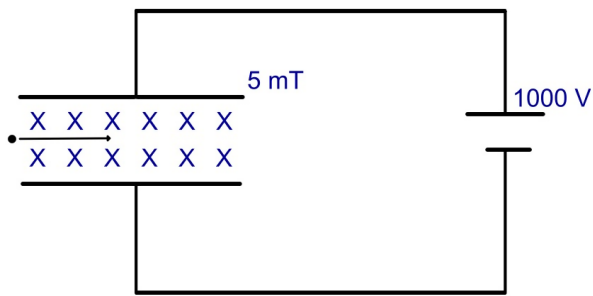
What velocity must it have to pass undeflected?

   a. 200 m/s
   b. 20,000 m/s
   c. 200,000 m/s
   d. 5000 m/s

7. A student designs a DC motor using a square loop between two permanent regular bar magnets.
   Which of the following modifications will NOT affect the frequency of the motor?

   a. increasing the number of turns
   b. connecting it to a higher voltage battery
   c. replacing the magnets with curved ones
   d. Moving the magnets closer to the loop of wire

8. A loop is turned 360° in a magnetic field and starts in the position as shown.
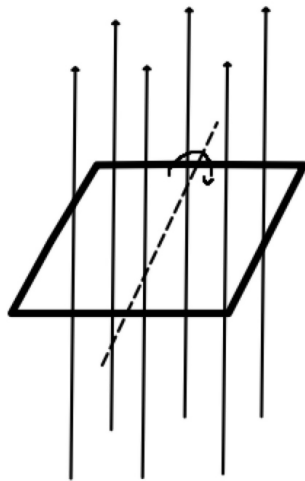
Which is true when the loop is at 90°?

	flux	EMF
a.	maximum	zero
b.	maximum	maximum
c.	zero	maximum
d.	zero	zero

9. A transformer is set up with an input of 20 V, and its output is connected to a 10 ohm resistor, as shown.
   What current flows through the resistor?

n = 500 turns   n = 200 turns   10 Ω   20 V
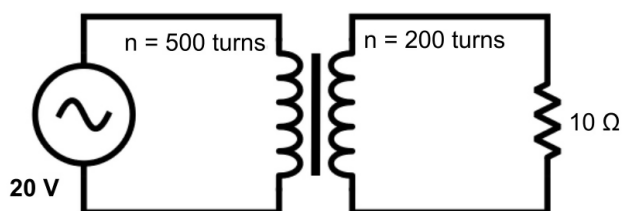
   a. 8 A
   b. 0.8 A
   c. 50 A
   d. 5 A

10. A bar is placed on a set of scales and another similar bar is suspended above it, as shown

A   5mm

10.0g
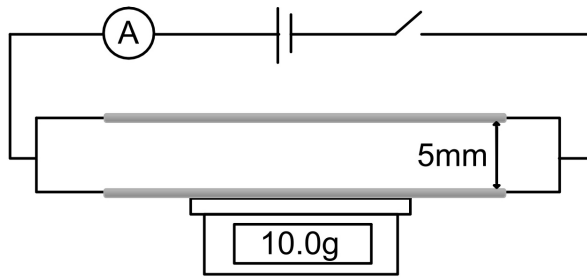
Both bars are 1 m and have the same properties. The top bar is fixed.
When the switch is closed, a current of 20A is recorded and the reading on the scales changes.
What is the new reading?

a. 10.4g
b. 9.6 g
c. 8.4g
d. 0g

11. Maxwell was responsible for unifying two areas of physics mathematically that were previously seen as discrete. What were these areas?

a. light and energy
b. matter and energy
c. electricity and magnetism
d. electromagnetism and light

12. Which property of a star can be directly determined by analysing its spectra?

a. mass
b. core temperature
c. volume
d. density

13. A 500 line per mm diffraction grating is used to determine the wavelength of a monochromatic light source. If the angle is 20°, what is the wavelength?
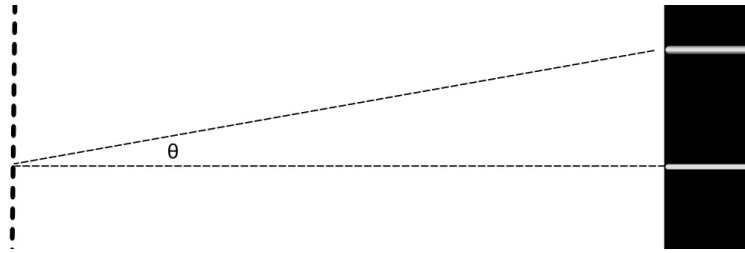
      a. 171 m
      b. 171 nm
      c. 684 µm
      d. 684 nm

14. What was Planck's contribution to Physics?

      a. He was able to explain the photoelectric effect.
      b. He was able to mathematically describe black body radiation.
      c. He established that light traveled in the form of photons.
      d. He developed the quantum theory of matter

15. If a 100m rocket travels at 80% of the speed of light, what will be its length as determined by the astronauts on board?

      a. 60m
      b. 80m
      c. 100m
      d. 167m

16. The HR diagram is a graph which classifies stars.

What are the labels of the x and y axes respectively?

	X axis	Y axis
a	temperature	luminosity
b	luminosity	temperature
c	mass	magnitude
d	temperature	mass

17. Which scientist determined the mass of an electron?

    a. Ernest Rutherford
    b. Nils Bohr
    c. JJ Thomson
    d. Robert Millikan

18. A photon is released when an electron in a hydrogen atom moves from an excited state where n = 3 to the next level down. Determine the frequency of this photon.

    a. 5.49×10^{14} Hz
    b. 6.56×10^{-7} Hz
    c. 1.52×10^{7} Hz
    d. 4.57×10^{14} Hz

19. Technetium 99m has a half life of 6.6hours. 1mg is administered to a patient in a medical scan.
   How much will remain in the patient's body after 26.4 hours?

   a. 2.5×10^{-3} g
   b. 6.25×10^{-5} g
   c. 6.25×10^{-3} g
   d. 2.5×10^{-5} g

20. The standard model proposes the existence of quarks. Which statement best describes the nature of quarks?

   a. Quarks are fundamental particles that make up hadrons. They are held together through the exchange of bosons.
   b. Quarks are fundamental particles and are also called hadrons. They are held together through the exchange of bosons.
   c. Quarks are fundamental particles that make up leptons. They are held together through the exchange of bosons.
   d. Quarks are fundamental particles that make up hadrons. They are held together through the exchange of leptons.

- End of Multiple-Choice Questions -

InspirED

InspirED

Physics
Section II Answer Booklet

80 marks
Attempt Questions 21 – 39
 Allow around 2 hours and 25 minutes for this section

Instructions

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

- Show all relevant working in questions involving calculations.

- Extra writing space is provided at the back of this booklet. If you are using this space, clearly indicate that your answer is continuing here and indicate which question you are answering.

Student Name: _____

1. a. An astronaut has a mass of 90kg. What is his weight on earth? (1 marks)

....

....

....

   b. The astronaut now goes to a planet that has twice the mass and twice the radius to that of Earth. What is their new weight ? (2 marks)

....

....

....

....

....

....

   c. The astronaut is now back in their spacecraft in orbit around the planet. Explain why the experience weightlessness. (3 marks)

....

....

....

....

....

....

....

....

2. In a set up similar to Millikan's experiment, a charged oil droplet is suspended between two electric plates.
    The oil droplet's mass is determined to be 5×10^{-4} g.

E = 1000 V/m

```
+ + + + + + + + + + + + + + + + +
```

O

```
- - - - - - - - - - - - - - - - - - - - - -
```
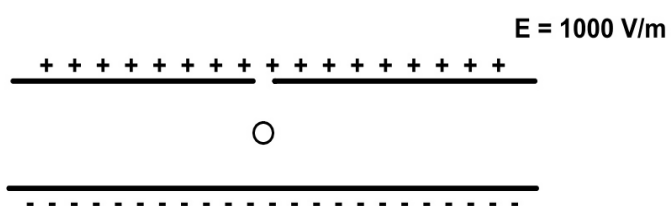
   a.   What is the net force on the oil droplet? (1 marks)

....

....

....

b. Determine the charge on the oil droplet. (3 marks)

....5

....

....

....

....

....

....

c. The strength of the electric field is increased and a uniform magnetic field
    is applied into the page. Describe the motion of the oil droplet. (3 marks)

....

....

....

....

....

....

....

3. A car goes around a banked turn as shown at 15 m/s.

1500kg

35m

θ

a. Label the forces acting on the car. (2 marks)

....

....

....

....

....

....

b. They hit an ice patch, which causes the road friction to drop to zero. What angle would the curve need to be at in order for the car to remain in the same position? (3 marks)

....

....

....

....

....

....

....

4. A muon is a subatomic particle that is created in the upper atmosphere at an altitude of 10km. Its half life is 2.2µs.

    a. If a million are created, calculate how many remain after 4.3 x 10-5 seconds. (4 marks)

....

....

....

....

....

....

....

....

....

....

....

InspirED

b. The muon's speed is 0.9997c. At that speed, the vast number of muons would not reach detectors on the earth's surface.
Explain, supporting your answer with calculations, why we are still able to detect them in high numbers. (3 marks)

....

....

....

....

....

....

....

....

5. A proton is fired in an electric field as shown
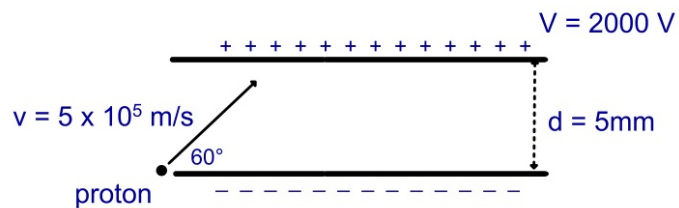
a. Calculate the force it experiences. (2 marks)

....

....

....

....

....

....

b. Describe the trajectory of the proton, supporting your answer with calculations. (4 marks)

....

....

....

....

....

....

....

....

....

....

6. A photocell is set up is connected to a voltmeter. Light is shone on the cell with various filters placed in its path, so that only specific wavelengths are allowed to pass through.
The results are

Wavelength (nm)	Voltage (V)
578	0.68
546	0.78
436	1.35
405	1.51
366	1.77

a. What is the frequency of light for the maximum voltage registered? (2 marks)

....

....

....

....

....

....

b. Draw a graph of the data, and using the graph, determine planck's constant. (4 marks)

....

....

....

....

....

....

....

....

....

....

7. A student set up a simple DC motor as shown between two magnets which sets up a magnetic field of B = 0.5T. The coil is a square of side 5cm.
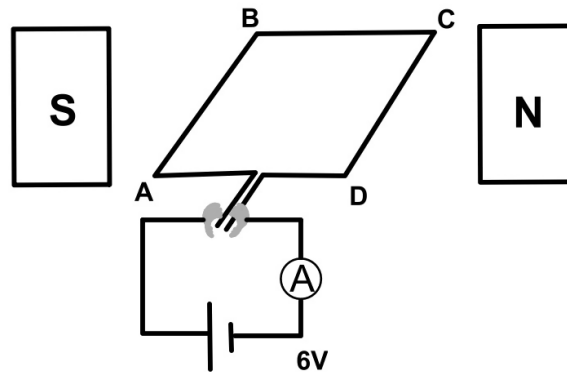
a. If the coil has a resistance of 3Ω, what is the force on side AB? (3 marks)

....

....

....

....

....

....

....

....

b. As it starts to turn the student momentary stops it when the coil is at 45°. What is the value of the torque at this point? (2 marks)

....

....

....

....

....

c. The student modifies the motor by increasing the number of turns to allow the motor to spin more effectively. But as the motor starts to speed up

they notice that the ammeter reading changes.
Explain why this occurs. (4 marks)

....

....

....

....

....

....

....

....

....

....

....

8. Using a labelled diagram, discuss how the HR diagram can be used to determine the relative age of a star. (6 marks)

....

....

....

....

....

....

....

....

....

....

....

....

....

....

9. Models in science serve useful tools in helping explain difficult concepts in simpler terms, but often have limitations. At times subsequent experimental evidence cause some models to be rejected all together.
Discuss how the model of the atom had changed from the time of JJ Thomson to Bohr. (7 marks)

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

10. A 5000kg telecommunications satellite is in a geostationary orbit, that is, it position, relative to the ground remains the same

    a. Determine the radius of its orbit? (2 marks)

    ....

    ....

    ....

    ....

    ....

    ....

    b. The satellite is now placed in a higher orbit, 500km further out. What energy must be supplied by the rockets to get it to this orbit? (4 marks)

    ....

    ....

    ....

    ....

    ....

    ....

    ....

    ....

    ....

    ....

InspirED

11. Discuss how spectra can be used to validate the Big Bang Theory. (6 marks)

....

....

....

....

....

....

....

....

....

....

....

....

....

....

12. The Large Hadron Collider (LHC) accelerates protons up to 99.99999% of the speed of light. These protons are then collided with similar protons travelling in the opposite direction. The collisions are then analysed to probe the fundamental nature of the atom. In 2012, these experiments confirmed the existence of the Higgs Boson, as predicted by the Standard Model.
Discuss the physics principles involved of getting the protons to this speed, the consequences of the collision and the knowledge that is gained from these experiments. (9 marks)

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

InspirED

....

....

....

....

....

InspirED