N11/4/PHYSI/HPM/ENG/TZ0/XX

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PHYSICS
HIGHER LEVEL
PAPER 1

Wednesday 9 November 2011 (afternoon)

1 hour

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.

1. The resistive force F acting on a sphere of radius r travelling with speed v through a liquid is given by the equation

$$F = 6\pi\eta rv$$

where η is a constant. What are the SI units of η?

A. $\text{kg m}^{-1}\text{ s}^{-2}$

B. $\text{kg m}^{2}\text{ s}^{-1}$

C. $\text{kg m}^{-1}\text{ s}^{-1}$

D. $\text{kg m}^{-1}\text{ s}^{-3}$

2. An ice-hockey puck is slid along ice in a straight line. The puck travels at a steady speed of 20 m s^{-1} and experiences no frictional force. How far does the puck travel in 2.5 s?

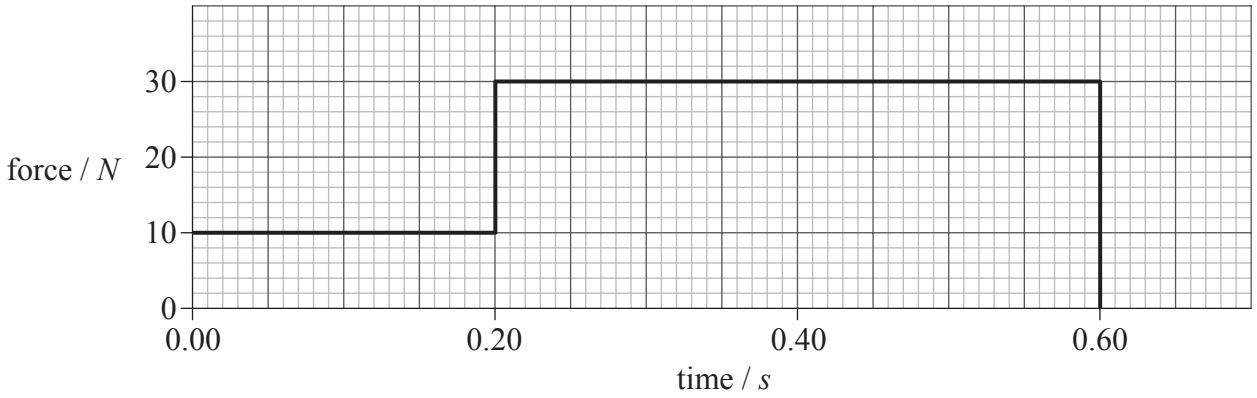
A. 5 m

B. 8 m

C. 25 m

D. 50 m

3. The graph shows how an external force applied to an object of mass 2.0 kg varies with time. The object is initially at rest.



What is the speed of the object after 0.60 s?

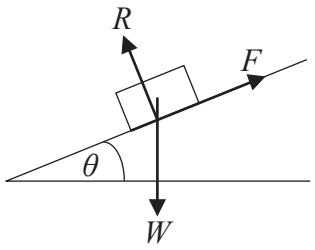
A. $7.0\,\text{m s}^{-1}$

B. $14\,\text{m s}^{-1}$

C. $18\,\text{m s}^{-1}$

D. $28\,\text{m s}^{-1}$

4. A block of weight W slides down an inclined plane at a constant speed.



The normal reaction acting between the block and the plane is R and the frictional force between the block and the plane is F. The incline is at an angle θ to the horizontal. What is the magnitude of F?

A. $R\cos\theta$

B. $R\sin\theta$

C. $W\cos\theta$

D. $W\sin\theta$

5. A car travels in a horizontal circle at constant speed. At any instant the resultant horizontal force acting on the car is

A. zero.

B. in the direction of travel of the car.

C. directed out from the centre of the circle.

D. directed towards the centre of the circle.

6. A ball is thrown horizontally from the top of a high cliff. Air resistance is negligible.

Which of the following correctly describes the changes, if any, to the ball's vertical speed and horizontal speed?

	Vertical speed	Horizontal speed
A.	no change	increases
B.	increases	no change
C.	no change	decreases
D.	decreases	no change

7. The escape speed of a rocket from the surface of Earth depends on the universal gravitational constant *G*. Other factors that may affect the escape speed are the

I. mass of Earth

II. radius of Earth

III. mass of the rocket.

Which of the above factors is/are correct?

A. I and II only

B. I and III only

C. II only

D. III only

8. A satellite in orbit about Earth moves to another orbit that is closer to the surface of Earth. When the satellite moves into the orbit closer to Earth, which of the following correctly describes the change in speed of the satellite and the change in its gravitational potential energy?

	Speed	Gravitational potential energy
A.	decreases	decreases
B.	decreases	increases
C.	increases	increases
D.	increases	decreases

9. Which of the following is equivalent to a temperature of 350 K?

A. −623 °C

B. −77 °C

C. +77 °C

D. +623 °C

10. The molar mass of magnesium is 24 g. 12 g of magnesium contains the same number of particles as

A. 6 g of carbon-12.

B. 12 g of carbon-12.

C. 24 g of carbon-12.

D. 6.02×10^{23} g of carbon-12.

11. The entropy of a system is a measure of the system's

A. total energy only.

B. degree of disorder and total energy.

C. degree of disorder only.

D. degree of disorder and average kinetic energy.

12. A fixed mass of an ideal gas is at temperature T. The pressure is doubled and the volume is halved. What is the temperature after these changes?

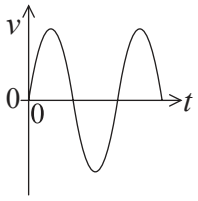
A. $\frac{T}{2}$

B. T

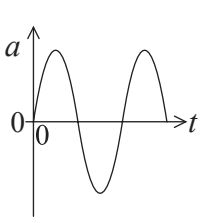
C. $2T$

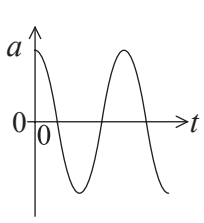
D. $4T$

13. The diagram shows the variation of velocity v with time t for an object performing simple harmonic motion.



Which of the following shows how the acceleration a varies with t?

A.


B.


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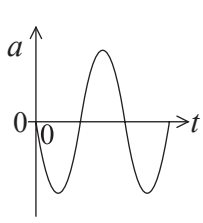

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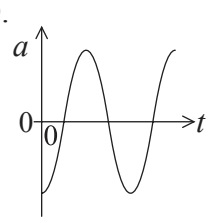


14. Which of the following gives regions of the electromagnetic spectrum in the order of **decreasing** frequency?

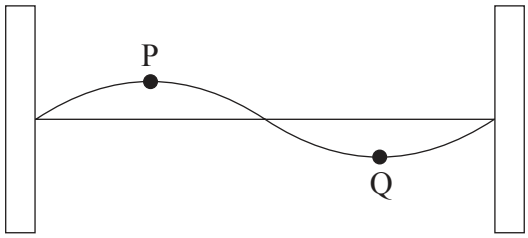
A. gamma-ray, microwave, visible

B. radio wave, infrared, microwave

C. ultraviolet, infrared, microwave

D. visible, gamma-ray, radio wave

15. A standing wave is established on a string between two fixed points.



What is the phase difference in radians between point P and point Q on the string?

A. zero

B. $\frac{\pi}{2}$

C. π

D. 2π

16. A fire engine with its siren sounding approaches and passes a stationary observer. The frequency of the sound emitted by the siren is f_s. The frequency of the sound measured by the observer is f_o. Which of the following describes the relationship between f_o and f_s?

	Fire engine approaching observer	Fire engine moving away from observer
A.	$f_o > f_s$	$f_o < f_s$
B.	$f_o < f_s$	$f_o < f_s$
C.	$f_o > f_s$	$f_o > f_s$
D.	$f_o < f_s$	$f_o > f_s$

17. The phenomenon of diffraction is associated with

A. sound waves only.

B. light waves only.

C. water waves only.

D. all waves.

18. The equation for the velocity of an object performing simple harmonic motion is $v = v_0 \sin \omega t$. Which of the following is a correct alternative form of the equation?

A. $v = v_0 \sin\left(\frac{2\pi}{T}\right)t$

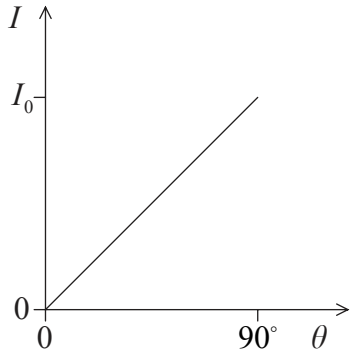
B. $v = v_0 \sin\left(\frac{t}{T}\right)$

C. $v = v_0 \sin 2\pi T t$

D. $v = v_0 \sin\left(\frac{T}{2\pi}\right)t$

19. Polarized light of intensity I_0 is incident on a polarizing filter. The angle between the plane of polarization of the incident light and the transmission plane of the polarizer is θ. Which graph shows how the intensity I of the light transmitted through the polarizer varies with θ?

A.



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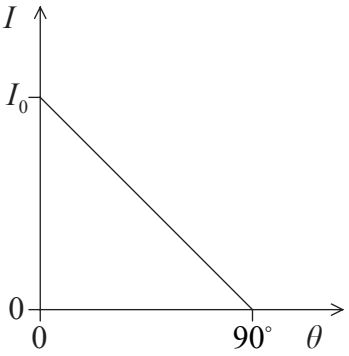
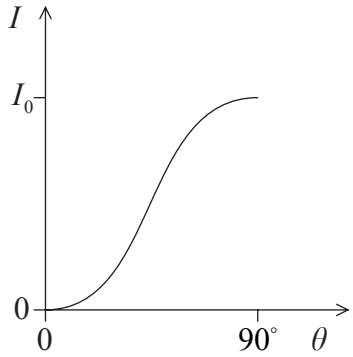
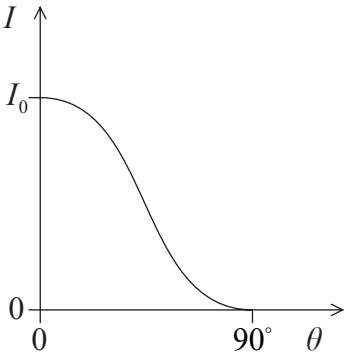


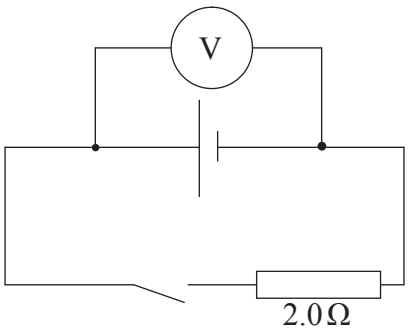
C.



D.



20. A cell is connected in series with a 2.0 Ω resistor and a switch. The voltmeter is connected across the cell and reads 12 V when the switch is open and 8.0 V when the switch is closed.



What is the internal resistance of the cell?

A. 1.0 Ω

B. 2.0 Ω

C. 3.0 Ω

D. 4.0 Ω

21. A resistor has a resistance R. The potential difference across the resistor is V. Which of the following gives the energy dissipated in the resistor in time t?

A. $\frac{Vt}{R}$

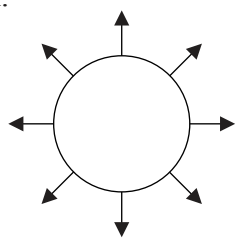
B. $\frac{Rt}{V^2}$

C. RV^2t

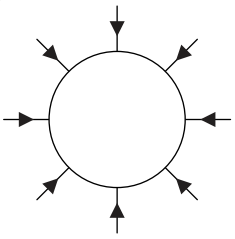
D. $\frac{V^2t}{R}$

22. Which of the following is the best representation of the electric field lines around a negatively charged metal sphere?

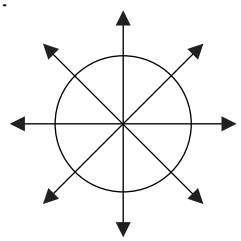
A.



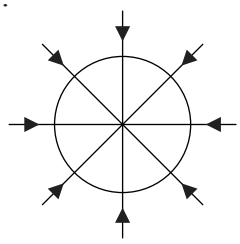
B.



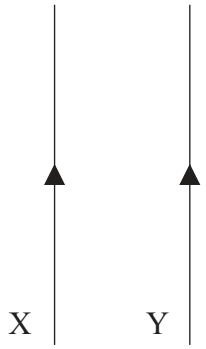
C.



D.



23. The diagram shows two long wires X and Y carrying identical currents in the same direction.



The direction of the force experienced by Y is

A. to the left.

B. to the right.

C. into the plane of the page.

D. out of the plane of the page.

24. The peak value of an alternating sinusoidal potential difference is 100 V. The approximate rms value of the potential difference will be

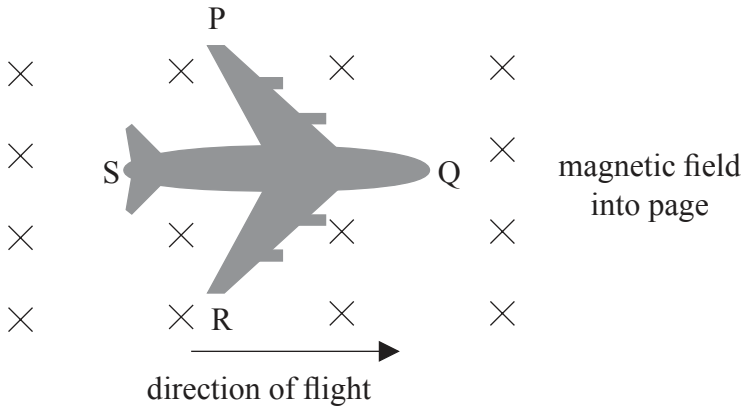
A. 50 V.

B. 70 V.

C. 140 V.

D. 200 V.

25. The diagram shows the view from above as an airplane flies horizontally through the Earth's magnetic field. The airplane is made of conducting material.



The direction of the induced emf will be from

A. P to R.

B. R to P.

C. S to Q.

D. Q to S.

26. In Geiger and Marsden's experiments a thin gold foil was bombarded with alpha particles. It was found that

A. all alpha particles were deflected from their original paths.

B. no alpha particles were deflected by more than 90° from their original paths.

C. a few alpha particles were deflected by more than 90° from their original paths.

D. most alpha particles were deflected by more than 90° from their original paths.

27. A fission reaction for uranium is

$$^{235}_{92}\mathrm{U} + \mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{A}_{Z}\mathrm{Kr} + 3\mathrm{n}$$

where n is the neutron. Which of the following gives the value of the nucleon number A and proton number Z for the krypton (Kr)?

	A	Z
A.	92	36
B.	36	92
C.	94	36
D.	36	94

28. A positively charged particle of charge q and mass m is accelerated from rest through a potential V. After acceleration the de Broglie wavelength of the particle is λ. Which of the following is equal to λ?

A. $\dfrac{h}{\sqrt{2mqV}}$

B. $\dfrac{h}{\sqrt{mqV}}$

C. $\dfrac{hq}{\sqrt{2mV}}$

D. $\dfrac{hm}{\sqrt{2qV}}$

29. Light is shone onto the surface of a metal and photoelectrons are emitted. Which of the following changes of wavelength and intensity of the light will increase the maximum kinetic energy of the photoelectrons?

	Wavelength	Intensity
A.	increase	no change
B.	decrease	no change
C.	increase	increase
D.	no change	increase

30. The probability of finding an electron at a particular position in a hydrogen atom is proportional to the

A. wavefunction.

B. square of the wavefunction.

C. amplitude of the wavefunction.

D. square of the amplitude of the wavefunction.

31. A proton decays to a neutron. The other products of the decay are a

A. positron and neutrino.

B. positron and antineutrino.

C. electron and neutrino.

D. electron and antineutrino.

32. The half-life of a radioactive nuclide is 20 s. What fraction of the original sample will have decayed in one minute?

A. $\frac{1}{8}$

B. $\frac{1}{4}$

C. $\frac{1}{2}$

D. $\frac{7}{8}$

33. Which of the following gives evidence to support the existence of atomic energy levels?

A. Alpha particle scattering

B. Absorption spectra

C. The existence of isotopes

D. Beta decay

34. What is the SI unit of energy density?

A. $\mathrm{J\,s^{-1}}$

B. $\mathrm{J\,kg^{-1}}$

C. $\mathrm{J\,m^{-2}}$

D. $\mathrm{kg\,m^{-3}}$

35. Wind of speed v is incident normally on a wind turbine of radius r. The maximum theoretical power output of the turbine is P. For wind of speed $2v$ incident normally on a similar turbine of radius $\frac{1}{2}r$, the maximum theoretical power will be

A. $\frac{1}{2}P$.

B. P.

C. $2P$.

D. $4P$.

36. The power emitted as electromagnetic radiation by the Sun is approximately 4×10^{26} W. The radius of the orbit of Mars around the Sun is approximately 2×10^{11} m. What is the best estimate for the power incident on an area of $1\,\text{m}^2$ at the radius of Mars' orbit?

A. 10^3 W

B. 10^7 W

C. 10^{11} W

D. 10^{15} W

37. Which of the following is **least** likely to increase the rate of global warming?

A. Melting of glaciers

B. Rising of sea-levels

C. Rising of sea temperature

D. Deforestation

38. The binary equivalent of the decimal number 27 is

A. 10101.

B. 11011.

C. 11001.

D. 10011.

39. The laser light used in a CD player has a wavelength of 600 nm. The pit depth of the CD is

A. 150 nm.

B. 300 nm.

C. 450 nm.

D. 600 nm.

40. The capacitance of a photodiode in a charge-coupled device (CCD) is 100 μF. The potential difference across the photodiode is 2 V. What is the charge stored in the photodiode?

A. 50 μC

B. 100 μC

C. 140 μC

D. 200 μC